The Solid Waste Management Resource Guide

For Massachusetts Schools

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection

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The Solid Waste Management Resource Guide

for Massachusetts Schools

1990

Michael S. Dukakis, Governor
Commonwealth of Massachusetts

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Executive Office of Environmental Affairs

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Department of Environmental Protection

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The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Quality Engineering
One Winter Street, Boston 02108

NIEL S. GREENBAUM
Commissioner

DEQE
NOW IS
THE DEPARTMENT OF
ENVIRONMENTAL PROTECTION

March 1990

DEAR EDUCATOR:

A strong, healthy environment is perhaps the best gift we can give our children. To accomplish this, society must learn to protect the earth's natural resources. I believe that to ensure and maintain the preservation of our environment, it is essential to cultivate environmental awareness in even the youngest members of society - our children.

The 1990's promise continued public focus on the environmental consequences of garbage disposal. The Commonwealth's Solid Waste Masterplan sets ambitious waste reduction and recycling targets for this decade, as well as new environmental protection standards. The success of this blueprint will depend, in large measure, on the public's support and participation.
To achieve this, we need well educated and informed participants. To this end, the Massachusetts Department of Environmental Protection is pleased to offer this comprehensive solid waste school resource guide to assist educators in teaching students about the solid waste management issues they face today and will confront tomorrow.

Each section of the guide begins with background information related to a solid waste concept followed by illustrative classroom activities for grades K-12. Educators are encouraged to adapt, change, adjust and apply these materials to meet their classroom needs. Many activities in one age level may be suitable for children in other grades. Additional information sources and materials are listed in the back of the guide.

The Department of Environmental Protection thanks the many individuals and organizations who assisted in developing this guide. An Educators' Advisory Committee, consisting of teachers and school administrators from across the Commonwealth, worked diligently with DEP in its drafting of the text and classroom activities. I also extend my gratitude to Waste Management Inc. and the Massachusetts Audubon Society for sponsoring dissemination and teacher training for the use of the guide.

Sincerely,

Daniel S. Greenbaum

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Massachusetts Audubon Society

South Great Road
Lincoln, Massachusetts 01773
(617) 259-9500

Dear Environmentalist:

The Massachusetts Audubon Society is pleased to be a partner in presenting **The Solid Waste Resource Guide for Massachusetts Schools.** When you open up this guide, you will be opening up a world of information about our environment along with educational tools for you and your students.

Solid waste is an urgent problem; in Massachusetts and around the world the price of disposing of our garbage, both financially and environmentally, has skyrocketed. In the next two years, two-thirds of the landfills in Massachusetts are expected to close, further complicating an already difficult problem.

There *are* answers. Recycling, reusing and reducing our solid wastes are all viable solutions that make environmental and economic sense. We can help to save our water resources, land, air and wildlife by educating ourselves and our children about waste management.

The Massachusetts Audubon Society is committed to high quality environmental education for all of the citizens of the Commonwealth. This guide will help us bring the environmental message of the 1990s to students throughout the state.

Teach on!

Sincerely,

Jerry Bertrand

Gerard A. Bertrand
President, Massachusetts Audubon Society

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RECYCLE AMERICA®
A Waste Management Service

Recycle America®
580 Edgewater Drive • Wakefield, Massachusetts 01880
617/246-4210

Dear Educator,

Those of us at Waste Management, Inc. find it entirely fitting that the year our country celebrates the twentieth anniversary of Earth Day also marks the production and statewide distribution of The Solid Waste Resource Guide for Massachusetts Schools.

Waste Management, Inc. is honored to sponsor this curriculum for it enables us to combine efforts with the Massachusetts Audubon Society in creating an awareness of the environment through educational efforts throughout the state.

We commend the Massachusetts Department of Environmental Protection for producing what we feel is one of the most comprehensive solid waste education resources in the United States and are particularly pleased with the recycling focus of this resource. Recycling a greater proportion of our municipal waste is an idea whose time has come. Testimony to that fact are the hundreds of communities across the country serviced by our Recycle America programs.

We hope The Solid Waste Resource Guide for Massachusetts Schools will serve to increase recycling initiatives across the state and we look forward to participating in the public sector/private sector partnership necessary to move Massachusetts forward on recycling activities.

Sincerely,

James M. Rooney

James M. Rooney,
Regional Manager

a service of Waste Management of North America, Inc.

USING THE RESOURCE GUIDE

Building public awareness is a critical step towards solving the state's solid waste dilemma. Teachers have a golden opportunity to reach our children and to help them understand what waste is, where it comes from, why it is a problem, and what can be done about it. Action by both teachers and students will be instrumental in solving our growing solid waste crisis.

This Resource Guide was developed for grades K-12. It reflects the Commonwealth's forward-looking legislation and program to develop a long-range solid waste management plan. The goals behind preparation of this material were to:

* help students realize a solid waste problem exists;
* make students understand that their attitudes and actions may contribute to this problem;
* present the state's four-step approach to solid waste management: reduce, recycle, incinerate, and landfill; and
* foster an appreciation among students that they can play a major role in solving our solid waste problems.

The material in this Guide is divided into four sections: an overview on what waste is; a brief history of solid waste management in Massachusetts; profiles on the four disposal strategies being promoted by DEP; and appendices. The background material is designed to provide educators with a broad base of information for completing the accompanying activities. Following each section of background material are complementary classroom activities. They are divided into two age groups, K-6 and 7-12. We encourage you to browse through both age groups for ideas. The activities are designed to increase the students' knowledge and awareness of solid waste issues, to enhance their educational skills through interdisciplinary studies, and to encourage active participation in understanding and addressing solid waste issues. You may wish to create solid waste units or use individual activities to supplement your regular curriculum. The appendices to the Guide contains sources used in the development of this project, as well as a glossary, and the names of organizations, publications, and audio-visuals that could provide supportive information on solid waste issues.

Solid waste affects land, air, water, and the overall quality of life. Waste management problems and their solutions range from simple and everyday to complex and high tech. Based on this, the subject is appropriate for kindergartners as well as high school seniors.

These resource materials are not intended to function as a curriculum. Rather, they should be viewed as a treasure chest of ideas and background information for you to use creatively and freely. Please feel free to photocopy these materials and share them with your colleagues. Additional copies may be obtained using the order form at the end of this manual.

WHAT IS WASTE?

WHAT IS WASTE ?

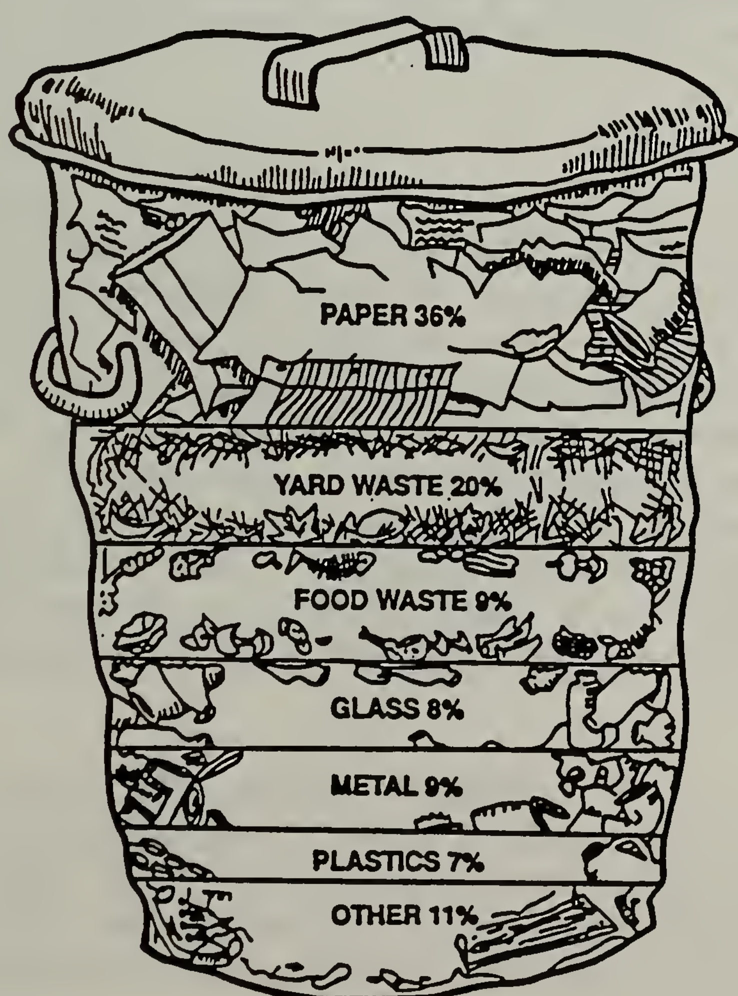
SOLID WASTE COMPOSITION

* Americans generate enough waste every year to fill a convoy of 10-ton garbage trucks, 145,000 miles long, which would circle the equator six times.[1]

* This trash includes enough aluminum to rebuild the American airfleet 71 times, enough steel to reconstruct Manhattan, and enough paper and wood to heat 5 million homes for 200 years.

Whether it is called garbage, trash, or refuse, solid waste can be described as almost anything that a person or business considers worthless and throws away. National figures show that Americans generate over 158 million tons annually, approximately one-half ton per person.

Municipal Solid Waste in Massachusetts, By Weight



Source: Franklin Associates Ltd.

In 1989, Massachusetts generated over 10 million tons of solid waste, of which more than 6.6 million tons was "municipal solid waste" from homes, classrooms, restaurants, stores, factories, building sites, and offices. The remaining 3.4 million tons of solid waste was composed of industrial wastes, sludge from waste water and industrial processes, demolition and construction debris, used appliances (called "white goods"), tires, waste oil, asbestos, and other solid wastes which require special handling in collection and processing or disposal at special facilities.[2]

Municipal solid waste (MSW) includes residential and commercial waste streams, as distinct from industrial waste streams. In 1988, the waste stream from residences accounted for 51 percent of MSW, while the commercial waste stream (industrial and institutional wastes) accounted for the remaining 49 percent.[3] Both waste streams include paper, leaf and yard wastes, metals, glass, food wastes, and plastics. The diagram on page 1 shows the composition of a typical American community's waste stream by percentage of material.

TRASH FACTS

PAPER

DID YOU KNOW THAT 36 percent by weight of everything we throw away is made from paper or paper board? Some examples of paper products we discard regularly include newspaper, cereal boxes and other food containers and packages, letters, magazines, tissues, toilet paper, and paper towels. Currently, the U.S. is the largest producer and consumer of paper and paper products in the world. In 1984, the United States consumed 78 million tons of paper and paper board products. Of this total, approximately 56 percent was thrown away, taking up more landfill space than any other human-made trash!

WHERE DOES ALL THIS PAPER COME FROM?

Paper is produced from wood. About 35 percent of the world's annual wood harvest is used to produce paper and this share is expected to grow to 50 percent by the year 2000. It takes approximately 17 trees to make one ton of paper. Fortunately, trees are a renewable resource, but we are currently harvesting our trees faster than we are replacing them. Without proper management or sufficient natural regeneration, some species of trees, as well as the production of paper and other wood products, could be threatened.

HOW IS PAPER MADE?

Paper is produced commercially in paper mills, which are usually located near the forests where the trees are harvested. Once the trees are cut down, they are debarked and chipped. These smaller pieces of wood are mixed with chemicals and processed in a large pressure cooker called a digester. This process helps to break the wood down into cellulose fibers. These fibers are rinsed to remove chemicals, unwanted wood contaminants, and dirt. The remaining wood-water mixture is called slurry and is fed onto screens which catch the fibers. The material on the screens is shaken to intermesh the fibers and drain any excess water. The resulting sheets of paper are passed through a series of rollers where they are pressed and dried. The final rolls of paper are produced by machines at rates as fast as 30 feet/second, and can be as wide as 16 feet.

PAPER PRODUCTS AND OUR ENVIRONMENT

In addition to depleting resources, paper production pollutes our environment. Producing one ton of paper may create as much as 84 pounds of air pollutants, 36 pounds of water pollutants, and 176 pounds of solid waste. This doesn't include the negative impacts resulting from the disposal of used paper and paper products.

RECYCLING AS A SOLUTION TO THE PAPER PROBLEM

Paper has become an integral part of our lives and plays an important role in many sectors of our society. It is a commodity which adds to our high standard of living and is essential in maintaining quality education, high health and safety standards, cost effective and efficient transportation of goods, as well as many of the conveniences we have come to depend on daily. Because we need paper, we must take steps to ensure its continued availability for ourselves and for future generations. If we recycled half of the paper used in the world today, we would meet almost three-quarters of the demand for new paper and save millions of acres of forest. Presently, we waste about three-quarters of our used paper by discarding it instead of using it to produce new products. Using waste paper instead of trees to manufacture paper products reduces water and energy consumption by 60 and 70 percent respectively, and the generation of environmental pollutants by 50 percent.

Despite these benefits, many paper manufacturers are hesitant to convert from virgin to recycled fibers because of associated equipment costs and the uncertainty of supplies and recycled paper markets. Increased consumer demands for recycled paper products may help offset these costs and encourage paper manufacturers to use and produce more recycled materials.

Recycling also helps to save resources for our future paper needs, as well as conserve trees which provide essential wildlife habitat and recreation opportunities, and help purify the air. In addition, recycling paper products extends the life of landfills by conserving valuable space. Nearly one-third of our waste stream by weight, and one-half by volume, is made up of paper. Recycling one ton of waste paper saves an average of three cubic yards of landfill space. And the best thing about recycling is that it's something that everyone can do.

Source: AVR *Teacher's Resource Guide*

TRASH FACTS

GLASS

DID YOU KNOW THAT 8 percent by weight of everything we throw away is made from glass? Some examples of commonly used glass items are jars and bottles which contain food, beverages, perfume, toiletries, cleaners, and medicines; window panes, light bulbs, and mirrors. It is estimated that each person in the U.S. uses almost 400 bottles and jars each year. Glass is popular because it's versatile, strong, and fairly easy to produce. Glass bottles were originally designed to endure 30 round trips from manufacturer to consumer, but because we often throw them away after using them only once or twice, the raw materials and energy invested in their production are often wasted. The bottle law, which passed in Massachusetts in 1983, has greatly increased the number of bottles recycled, although many glass containers are exempt and are discarded as garbage.

WHERE DOES GLASS COME FROM?

Glass is produced from minerals. Silica, more commonly known as sand, is the primary ingredient used in its production. Silica is the most common substance in the earth's crust and although it is a non-renewable resource, we have quite a large supply. It takes 1,330 pounds of sand, 433 pounds of soda ash, 433 pounds of limestone, 151 pounds of feldspar, and 15.2 million BTUs (British Thermal Units) of energy to produce 1 ton of glass. The soda ash (sodium carbonate), lowers the melting point of silica and helps regulate the consistency of the mixture. Limestone (calcium carbonate) is added to stabilize the mixture and keep it from dissolving in water. Different colored glass is produced by adding small amounts of other substances such as iron, copper, and cobalt. Green glass, for example, is made by adding iron.

HOW IS GLASS MADE?

Glass is produced in factories where the raw materials are melted together and transformed into bottles, jars, and other products. There are 90 glass manufacturers in the U.S. which produce a total of approximately 80 million containers a day. The mixture of silica, soda ash, limestone, and feldspar is called a "batch" of glass. The batch is mechanically fed into large furnaces and heated to temperatures as high as 2,800° F. When it is completely melted, it is transferred to a glass forming machine where "gobs" of molten glass are dropped into molds for shaping. Compressed air is then forced into the center of the mold blowing the glass out against its walls, forming the desired shape. This formation process only takes about 13 seconds. Finally, the containers are placed on conveyor belts and slowly passed through cooling tunnels to prevent shattering. Slow cooling, in addition to a protective coating, strengthens the glass and increases its durability. In about one hour, the bottles are cool enough to touch and can be labeled, filled and sent to market.

GLASS, ENERGY, AND THE ENVIRONMENT

The raw materials used to produce glass are plentiful and fairly accessible, but the process of transforming them into glass requires a lot of energy. It takes about 7,600 BTUs of energy to produce just one pound of glass. In addition, the manufacturing of one ton of glass can generate as much as 385 pounds of mining waste and 28 pounds of air pollutants.

REUSING AND RECYCLING GLASS

Reusing glass at home conserves resources and energy. Industries can also help by cleaning and refilling glass containers, although their energy savings are partially offset by the energy expended in the cleaning and transport of the used bottles.

Recycling glass also saves resources and energy and can reduce the amount of waste and pollution generated by glass production. Adding cullet, (old glass containers broken into small pieces), to the batch saves energy by lowering its melting point. The temperature of the furnace can be lowered 10 degrees for every 10 percent cullet added. Because a new batch of glass may contain up to 83 percent cullet, using old bottles to make new ones can conserve a significant amount of energy. Using 1 ton of recycled glass will also save 1.2 tons of raw materials and reduce mining wastes and other harmful by-products of glass production. It has been estimated that using 50 percent recycled glass in the manufacturing of new glass can reduce mining wastes by 79 percent, water consumption by 50 percent, and air emissions by 14 percent. Finally, recycling glass saves precious landfill space. Instead of becoming trash and lying in landfills for thousands of years, bottles and jars can be used over and over again.

Sources: AVR *Teacher's Resource Guide*; *Oscar's Options*

TRASH FACTS

METAL

DID YOU KNOW THAT 9 percent of everything we throw away is made from metal? Iron and aluminum are the metals most frequently used in the production of items we use daily, such as food and beverage containers, pie plates, frozen food trays, foil, car and aircraft parts, gutters, pipes, window frames, construction beams, appliances, etc. The chemical composition and structure of these metals result in products that are strong and durable, even when exposed to the elements. For example, an aluminum can left outside will take 500 years or longer to disintegrate to dust. Unfortunately, the very properties which make metal products extremely useful and versatile also contribute to problems associated with their disposal.

WHERE DOES METAL COME FROM?

Metals are elements or mixtures of elements which occur naturally in the earth. Abundance, accessibility, and the processing required to transform these natural substances into a usable form varies with the type of metal.

ALUMINUM: Aluminum is the third most common element and constitutes 8 percent of the earth's crust. Although it is quite common and can be found dispersed throughout most rocks and clays, it is never found naturally in its metallic state. The greatest concentration of aluminum is found in bauxite ore, which contains large amounts of alumina. Most of the world's bauxite reserves are in the subtropics where heat and water weather away other elements, leaving a high concentration of alumina. The U.S. imports 85 to 90 percent of its bauxite.

Surface mining of bauxite requires a large energy input and generates solid, waterborne, and hazardous wastes, as well as air pollution. After the bauxite ore is extracted from the ground, it is transported to refineries where the alumina is chemically separated from the ore. The aluminum is then extracted from the alumina through an energy-intensive process called electrolysis. Small amounts of other metals or alloys may be added to the aluminum to strengthen it.. The melted aluminum is then cast into ingots and sent to manufacturing plants where it is remelted and formed into items such as cans, trays, foil, and aircraft and car parts. Aluminum is often used when a strong, durable, yet light weight, material is needed.

IRON, STEEL, AND TIN: Iron is also a naturally occurring element. Steel is produced by adding carbon to iron. Different grades of steel are produced by adding various elements to this basic mixture. Tin is another metallic element. "Tin" cans are really steel cans with a thin coating of tin which prevents the steel from rusting or corroding. Steel is very strong and is the most widely used metal today. The mining and processing of iron is quite costly, energy intensive, and has serious environmental impacts.

DIFFERENTIATING BETWEEN METALS

You can tell the difference between tin (steel) cans and aluminum cans with a magnet. Magnets will attract steel, but not aluminum. Bimetal cans are tin cans with an aluminum top. A magnet will attract these cans if pointed at the steel or tin portion, but not if placed near the aluminum top.

BENEFITS OF RECYCLING METAL PRODUCTS

Metal products are very popular and are used extensively throughout the world. We have come to depend on metal products for transportation of people and goods, sturdy building materials, and sanitary packaging and storage of food and beverages. It is clear that as population and the standard of living increases worldwide, so too will the demand for metal products. Unfortunately metals are non-renewable resources and their extraction from the earth is expensive, energy intensive, consumptive, and detrimental to the environment. Recycling metal and reusing it to make new cars, airplanes, pipes, cans, appliances, window frames, etc., can offset the monetary and environmental costs while meeting increased demand. Discarded metals are quite valuable because they've already gone through the costly extraction process. Pure aluminum cans are 100 percent recyclable and using them to produce new aluminum products can reduce energy consumption, and air and water pollution by approximately 95 percent.

Recycling steel can reduce energy consumption by 74 percent, with an 86 percent reduction in air pollution, a 40 percent reduction in water use, a 76 percent reduction in water pollutants, and a 97 percent reduction in mining wastes. When 1,000 tons of steel are made from scrap metal rather than virgin materials, enough energy is saved to supply the electrical needs of an American family for almost one year! For each ton of scrap metal used, one and-a-half tons of iron ore and one-third of a ton of coke/coal are saved. In addition to conserving resources, energy, and the environment, recycling metal materials saves landfill space. Every pound of metal that you recycle means one less pound of metal for your community to dispose of.

Despite the evidence that recycling is a cost effective means of producing metal products, only one percent of all metal is recycled after its first use. This is not because the metals cannot withstand continued use, but because it involves major changes for citizens and businesses alike. Serious citizen commitment to recycling metals will send a clear message that we are no longer willing to waste our valuable resources, energy, and landfill space when more cost effective and efficient methods of producing metal goods exist.

Sources: AVR *Teacher's Resource Guide*; *Oscar's Options*

TRASH FACTS

PLASTIC

DID YOU KNOW THAT in Massachusetts plastics account for about 8 percent by weight of everything we throw away, and represent about three times that amount in volume? Since the end of World War II, plastics have become extremely popular in America, and are used to produce many items we rely on daily, including milk and juice jugs, soda bottles, food wraps, garbage bags, and several types of packaging. In addition, plastics have contributed to many scientific breakthroughs and have played a major role in the development of important products such as contact lenses, artificial hearts, more fuel-efficient cars, and portable computers. Plastics are lightweight, durable, waterproof, versatile, relatively inexpensive to produce, and increase the mobility and shelf life of many products. These properties make plastics very desirable to both consumers and manufacturers, and as a result, they have been replacing traditional materials such as glass, aluminum, steel, and paper. Unfortunately, the very properties that make plastics appealing, also create complex problems during their production and disposal.

WHAT IS PLASTIC MADE FROM?

Plastics are synthetic materials derived from petroleum and natural gas. Petroleum and natural gas are also used as energy sources for plastic production. Availability of these scarce, non-renewable resources is a critical issue underlying the continued use and disposal of plastics. At current consumption rates, world-wide reserves of accessible petroleum and natural gas are only expected to last for another 30 to 60 years.

HOW IS PLASTIC MADE?

Plastics are commercially manufactured and consist of various combinations of carbon with hydrogen, oxygen, nitrogen, and for some types chlorine and fluorine. They are made by linking together small molecule groups called "monomers" into long-chain molecules called "polymers." When this chemical rearranging occurs, a plastic resin is formed. While in a liquid form, plastics can be molded and cast into many different shapes. Plastic resins are used to produce hundreds of different types of plastic, all of which fall into two basic categories, thermoset and thermoplastic.

Thermoset plastics harden permanently, making them difficult to recycle. Thermoset are used to produce products that require a hard, durable, and permanent plastic such as, furniture, toys, tableware, and computer casings. These items constitute approximately 13 percent of plastic sales in the United States. Thermoplastics will also harden when cooled, but may be remelted and molded into new plastic products. This characteristic makes thermoplastics good candidates for recycling. The thermoplastic resin types most commonly used in the U.S. and most frequently seen in the waste stream are:

High Density Polyethylene (HDPE), which is used for the majority of rigid containers such as milk and orange juice jugs, plastic "tubs" for butter and margarine, containers for ice cream, cosmetics, medicine, and for heavy-duty trash bags.

Low Density Polyethylene (LDPE) is used extensively in packaging materials such as clear wrap, supermarket produce bags, bread bags, dry-cleaning bags, and for coating other containers such as milk and juice cartons.

Polypropylene (PP) is used for durable items including battery cases, furniture, fibers for rope and strapping, cellophane-like food wrappers, and in some of the many layers of multi-layered plastic containers.

Polystyrene (PS) is best known in its foamed form, better known by Dow Chemical's trademark, Styrofoam. It is used for products such as food trays, egg cartons, hot cups, and "clamshell" containers for hamburgers and other take-out foods. Polystyrene is also used to produce plastic cutlery, disposable razors, prescription and vitamin bottles, mini-containers for cream, and packaged cookie trays.

Polyvinyl Chloride (PVC) is a versatile plastic because its tough, yet can be modified by additives to make the product flexible. PVC is primarily used for durable construction products such as pipes, siding, cables, and gutters. Commonly known as "vinyl," it also is used extensively for flooring, paneling, siding, luggage, footwear, upholstery, clothing, camping gear, and beach rafts. About 25% of the PVC produced is used for disposable packaging.

Polyethylene Terephthalate (PET) has been used extensively since 1977 for soft drink bottles. It is also used in other packaging materials such as plastic jars, sheeting, and blister packs, as well as for certain appliance and auto parts.

Multi-layer Plastic containers consist of five to seven different layers of plastic, in order to combine the properties of strength, flexibility, and puncture prevention. These containers help to protect the flavor and texture of food items, and increase product shelf life. Squeezable ketchup bottles are prime examples of multi-layered plastic containers.

WHY ARE PLASTICS A PROBLEM?

The production of plastics requires large quantities of crude oil and natural gas, and generates a significant amount of solid waste, as well as air and water pollutants. Each day, millions of plastic products are discarded, and the raw materials and energy used to produce them are wasted. Disposal of these bulky items consumes precious landfill space, and generates air pollution when burned in combustion facilities. For example, burning polyvinyl chloride (PVC), releases chlorine gas into the atmosphere which threatens human health and contributes to the depletion of the ozone layer. The burning process also creates hydrochloric acids which can corrode the inside of the combustion chambers, resulting in an increase in atmospheric emissions.

In addition to the problems associated with the production and subsequent disposal of plastic waste, many plastic items are disposed of improperly, and end up in our oceans, rivers, lakes, and along roadways. This plastic litter threatens the health of many species of wildlife and often compromises the natural beauty of these areas. Plastic garbage commonly found in U.S. waters include discarded six-pack yolks, fishing lines and nets, plastic bags, utensils, and plastic strapping. It is estimated that plastic litter accounts for the deaths of approximately 100,000 marine mammals per year, including endangered species of turtles and whales.

Plastic products and packaging have become necessities in our convenience-oriented society. It is estimated that approximately 13 percent by weight, and as much as 30 percent by volume, of all packaging discarded in 1986 was plastic. In Massachusetts, plastics account for approximately 200,000 pounds of solid waste per year. Plastics do not rust, biodegrade, dissolve, or evaporate when exposed to the elements. Although most plastic products are used only briefly, they will remain in our environment for a long time and will continue to create serious waste management and pollution problems. At current rates of production, consumption, and disposal, the resources used to produce plastic products, as well as the space needed to dispose of them, will soon be exhausted.

WHAT ARE BIODEGRADABLE AND PHOTODEGRADABLE PLASTICS?

The litter and marine pollution problems associated with plastics have prompted keen interest in the development of degradable plastics that break down naturally and disappear over time. True biodegradable plastics that could be broken down into organic substances by bacteria and fungi are presently in the experimental stage and are not available for general use.

Recently, several plastic products such as trash bags and disposable diapers have been advertised as "biodegradable." These plastics are oil-based and contain additives such as cornstarch. Bacteria readily feed on the starch in the blend and although this action breaks up the plastic material into small fragments, these little pieces of the oil-based plastic remain in the environment.

Photodegradable plastics are blended with additives that degrade when exposed to the ultraviolet rays in sunlight. Direct exposure to sunlight for extended periods of time causes these materials to become brittle and the plastics break down into smaller pieces. Manufacturers are currently producing six-pack yolks from photodegradable plastics and are required to do so by law in over twelve states, including Massachusetts. Other commercial products made with photodegradable plastics include trash bags and agricultural mulches. While these items break down into smaller pieces of plastic in the sunlight, photodegradable plastics are basically the same as regular plastics when buried in landfills.

HOW ARE PLASTICS RECYCLED?

Most experts agree that plastics recycling can develop into a major option for managing plastic wastes. The guiding principle behind recycling plastics, is to convert those items with short useful lifespans, such as a milk jug, into plastics with long life-spans, like plastic piping. The success of plastics recycling depends in part on the proper identification and separation of plastic resins. To help with the identification problem, the Society of the Plastics Industry (SPI) is sponsoring a voluntary coding system to encourage manufacturers to label the resins in the plastics they produce. One concern about the codes is the difficulty of reading them after a container has been flattened.

Currently, the types of plastic materials most often recycled are plastic bottles made from polyethylene terephthalate (PET) and high-density polyethylene (HDPE). Successful recycling of these plastics is due to the relative ease of sorting and reprocessing these materials, their high reuse value, and collection mechanisms mandated by container deposit laws which are already in place. In general, recycled plastic materials cannot be reused for packaging because they are not sufficiently sterilized during the recycling process, and do not meet Food and Drug Administration (FDA), standards. PET soda bottles are recycled into scouring pads, paint brushes, fiberfill for pillows, ski jackets, sleeping bags, carpet fibers, rope, sails and tire cord. HDPE plastic found in milk and juice jugs, bleach, and detergent bottles can be recycled into lumber substitutes, base cups for soft drink bottles, flower pots, pipes, toys, kitchen drain boards, trash bags, and signs.

Two major projects to recycle polystyrene foam packaging began in the U.S. in 1989. Various types of foam packaging waste are being collected, flaked, remelted and pelletized. The recycled polystyrene can be mixed with virgin PS to produce coat hangers, flower pots, wall and building insulation, and protective packaging. One of the major products made from mixed plastics is plastic "lumber." Plastic lumber is used for posts, poles, marine pilings, dock surfaces, piers, fences, park benches, and parking space bumpers.

By recycling plastics we can save energy, resources, landfill space, and help to protect our environment. The technology for recycling plastics currently exists, but its success depends on public support. The only way to increase demands and develop markets for recycled plastic products, is to start recycling.

Sources: Plastics Recycling Action Plan for Massachusetts; *Facing America's Trash: What Next for Municipal Solid Waste*; AVR *Teacher's Resource Guide*.

HOUSEHOLD HAZARDOUS WASTE

The average American stores three to ten gallons of household hazardous waste at any given time. Examples of household products which contain toxic or polluting chemicals include paints, septic tank cleaners, fingernail polish, drain cleaners, disinfectants, pool chemicals, pesticides, hobby supplies, car batteries, used motor oil, and laundry bleach.

People are generally unaware of the potential dangers of using, storing, and disposing of common household substances. Some potentially severe consequences of careless disposal of these products include:

* pollution of drinking water supplies, ponds, harbors, and rivers;

* injury to trash collectors during curbside pick-up resulting from chemicals that when mixed together can cause fires, acid burns, and/or the release of toxic fumes;

* evaporation of solvents contained in products such as household paints, varnish strippers, and even fingernail polish, contributing to smog and other air pollution problems;

* injury to firemen battling fires involving large amounts of flammable substances (e.g., gasoline or paint thinner) and pesticides stored in homes and garages; and

* destruction of important bacteria necessary to properly break down wastes in sewer and septic systems.[4]

Several of the classroom activities found later in this chapter include fact sheets which outline safer usage and disposal tips, and give alternatives to toxic products.

TRASH FACTS

PROBLEM WASTES

BATTERIES and WASTE OIL are two components of our waste stream that require special attention during disposal. Unlike many potentially hazardous materials, small quantities of these items are used and discarded by ordinary individuals each day and are generally regarded as harmless. Proper use is rarely dangerous, but when these items are included in the waste stream to be landfilled or incinerated they can threaten our health and the integrity of our environment. It is important, therefore, to make sure that they are separated from the rest of our trash, and properly discarded or recycled.

BATTERY FACTS

WHAT IS A BATTERY?

Batteries are electro-chemical devices that convert chemical energy into electrical energy and provide power for many commonly used items including toys, video games, flashlights, radios, cameras, hearing aids, tape decks, and other electronic devices. The basic battery cell consists of a negative electrode (anode), a positive electrode (cathode), and an electrolyte, which is a solution through which an electrical current can travel. There are two types of batteries: primary cells and secondary cells.

Primary Cells: A primary cell is not rechargeable and ceases to work when the active chemicals that produce the energy are depleted. Most common household batteries are primary dry cells. They are not designed to be recharged and attempting to do so may cause them to explode! There are several types of primary cells but alkaline zinc/manganese, carbon/zinc, silver/oxide, and mercury/oxide are those most often used in household products.

Secondary Cells: Secondary cells are rechargeable and can be used repeatedly. The chemical reaction that creates the electricity can be reversed, thereby allowing an electrical current to recharge the battery. A common example of a secondary cell is a car battery. Rechargeable household batteries are also available along with special charging units.

WHY ARE BATTERIES A PROBLEM?

Household batteries are undesirable in the waste stream because they contain heavy metals and other chemicals which can harm the environment and threaten human health. When batteries are buried in landfills or left in dumps, heavy metals such as mercury, lead, copper, zinc, cadmium, and manganese can leach into ground and surface water. When incinerated, these metals are either released into the atmosphere or are trapped in the incinerator ash and subsequently landfilled. Again, leaching can result in the contamination of ground and surface water.

Most heavy metals are highly toxic to people and animals and can cause a variety of serious health disorders. Unlike most organic compounds (those containing carbon), heavy metals do not decay or break down in the environment. Because plants and animals cannot metabolize these substances, they accumulate in the tissues of these organisms. As larger animals eat smaller animals or plants which have been contaminated, the heavy metals become more and more concentrated and continue to bioaccumulate as they make their way up the food chain.

IS BATTERY DISPOSAL A BIG PROBLEM?

The American family uses an average of 32 dry cell batteries a year for toys, flashlights, radios, calculators, and other common household items. After becoming discharged, they are generally discarded and become part of the waste stream. Although each battery may be small, 25 percent of the cadmium, 45 percent of the mercury, and 66 percent of the lead produced in this country are used in their production and significantly contribute to the amount of these substances in our waste stream.

WHAT CAN WE DO WITH ALL OF THESE BATTERIES?

Fortunately, there are safe alternatives to adding batteries to our waste stream. Purchasing rechargeable household batteries (secondary cells) is one way to reduce the volume of discarded batteries. (NOTE: Before recharging any battery, make sure that it is a secondary, rechargeable cell; primary cell batteries, although similar in appearance, are not designed to be recharged and attempting to do so could cause them to explode.

Another option is to recycle batteries, although technologies and markets are somewhat limited. Currently those most easily recycled are button cell batteries used in hearing aids and cameras. European technology is available for recycling the more commonly used standard cells, but markets for the recycled materials do not yet exist in the United States. Developing these markets, especially for the standard alkaline zinc/manganese cells, is extremely important because they are growing in popularity. Although these batteries contain approximately one percent mercury, which is much less than the button cells, it is estimated that they will constitute approximately three-quarters of all household batteries sold in 1990. Removing them from the waste stream could significantly reduce the mercury content of incinerator emissions and ash, as well as landfill leachate.

As people become more aware of the serious ramifications associated with carelessly discarding batteries, technologies and markets for recycling them should open up. Meanwhile, it is important to separate non-recyclable batteries from household trash and to dispose of them at your community's household hazardous waste collection center.

Sources: AVR *Teacher's Resource Guide*; *Household Batteries: Management or Neglect?*; *Recycling in the 1980s: batteries not included*

OIL FACTS

WHAT IS WASTE OIL?

Waste oil is motor oil that has been used in cars, trucks, boats, trains, and other engines that need oil to function properly. Americans generate more than 600 million gallons of used motor oil each year, one-half of which is produced by do-it-yourself mechanics. Unaware of the potential dangers associated with adding used oil to the environment, many people discard their waste oil wherever it is most convenient. It is estimated that through this "innocent dumping," 240 million gallons of waste oil enters the environment each year. In other words, do-it-yourself mechanics dump the equivalent of the Exxon Valdez oil spill every two and one-half weeks!

WHY IS WASTE OIL DANGEROUS?

Waste oil contaminates water supplies, poses serious health threats, and can cause extensive environmental problems. One gallon of used oil can contaminate and foul the taste of one million gallons of fresh water, which is equivalent to one year's supply of water for 50 people. One pint of used motor oil can produce an oil slick slightly larger than a football field and will kill floating aquatic organisms and algae which are food sources for fish. As fish eat these contaminated organisms, oil accumulates in their bodies. Oil also prevents the replenishment of dissolved oxygen in the water, further threatening the lives of fish and other aquatic creatures. As contaminated organisms are eaten by fish, birds, and people, components of the waste oil move up through the food chain and can cause serious health disorders and genetic abnormalities. Human health is threatened by waste oil if we drink contaminated water, eat fish or animals who have ingested oil, or if our skin is directly exposed to it for long periods of time.

In addition, many additives and contaminants present in waste oil increase its toxicity. For example, several substances are added to automotive oil to prevent rusting of engine parts and to enhance oil performance. The breakdown of these additives, contaminants from engine wear, and the infiltration of gasoline and combustion byproducts, causes high levels of heavy metals such as lead, zinc, magnesium, and cadmium, as well as benzene and other potentially harmful substances found in used oil. If not disposed of properly, these materials can contaminate water supplies, enter the food chain, and cause long-term ecological damage.

HOW DOES WASTE OIL ENTER THE ENVIRONMENT?

Unaware of the potential dangers associated with improper disposal of even small amounts of waste oil, many consumers pour their used oil on the ground, down the sink, into storm drains, or discard it with the rest of their trash which is landfilled or incinerated. A number of problems result from these disposal methods. Burning oil can cause serious air pollution problems. When oil is dumped on the ground or buried, it can leach into groundwater and contaminate drinking water supplies. Oil poured into storm drainage systems that carry rain water directly into streams, lakes, and rivers can seriously pollute these waterways and the life they support. In many sewage systems, waste water proceeds to treatment plants. If waste oil contaminates this water, it can kill the bacteria that help break down sewerage and purify the water. Not only does this diminish the effectiveness of the treatment, but water contaminated with oil is often discharged from these plants into rivers and coastal waters. It has been estimated that sewage treatment plants discharge twice as much oil into coastal waters as do oil tanker accidents--15 million gallons per year verses 7.5 million gallons per year. While it is quite difficult to prevent oil tanker accidents, we can effectively manage our waste oil to ensure that it doesn't haphazardly enter and pollute our waterways and the environment.

RECYCLING WASTE OIL SAVES RESOURCES & THE ENVIRONMENT

Improper disposal of used motor oil not only threatens human health, it also squanders a non-renewable and scarce resource. Waste oil can be cleaned or re-refined and used indefinitely as a lubricant. It only takes one gallon of used oil to produce 2-1/2 quarts of lubricating oil, while 42 gallons of crude oil are needed to produce the same amount of lubricating oil.

Waste oil can also be recycled and used as a fuel or fuel supplement. This is the primary means of recycling oil in Massachusetts since there are no refineries in the northeast. Recycling the used motor oil dumped by do-it-yourself mechanics in one year would generate enough energy to power 360,000 homes for a year. Re-refining this same amount would produce 96 million quarts of lubricating oil.

RECYCLING OIL IN MASSACHUSETTS

Lack of disposal options, and a limited knowledge of the associated health and environmental hazards, have led to improper disposal of oil in the United States. Fortunately, Massachusetts provides consumers with a convenient and responsible alternative to dumping their waste oil. State law requires all motor oil retailers to accept for free up to two gallons of waste oil per day rom every customer presenting a valid proof of purchase. The retailer is responsible for having this oil recycled in compliance with the Department of Environmental Protection's (DEP) Hazardous Waste Regulations. Usually this means hiring a licensed transporter to haul the oil to a recycler. The consumer is responsible for bringing waste oil to the store where it was purchased in a clean, secure, and unbreakable container. It is important that oil is not mixed with gasoline, antifreeze, water, or any other substances because contamination will hinder the recycling process.

In addition to disposal opportunities provided under this state law, some communities have set up waste oil collection centers where residents can bring their used oil for recycling. With these choices available, it's now up to citizens to ensure that they dispose of waste oil in a safe and environmentally-sound manner.

For further information on recycling oil in Massachusetts, call DEP's used oil hotline at 617-556-1022.

Sources: AVR *Teacher's Resource Guide*; Massachusetts Department of Environmental Protection, Division of Hazardous Waste

NATURAL RESOURCES FACTS

WHAT ARE NATURAL RESOURCES?

Natural resources are valuable, naturally-occurring materials on which we and other living organisms depend. Some examples of natural resources include air, water, soil, rock, minerals, plants, wildlife, metals, and fossil fuels. They can be mined from the ground, harvested from forests and fields, or removed from the atmosphere. Every product we use and produce is derived from one or more natural resources. As a result, our continued existence, as well as the lifestyle we maintain, is directly related to the abundance, availability, and quality of these raw materials, as well as our ability to obtain them. Because of this, a great deal of time and energy is spent locating and transforming raw materials into products we need and use. Although it is sometimes difficult to recognize the source of manufactured or processed items, everything can be traced back to the earth. Take, for example, a fast food hamburger. The burger is made from beef which comes from a cow. The bun is made from grains, which like the grass that cows feed on, grow in soil and are nourished by minerals, water, and sunlight. The styrofoam box is made from fossil fuels extracted from the earth. In addition, a lot of energy, also derived from natural resources, is used to transform the raw materials into the hamburger. Producing just one burger requires many natural resources, often tapping sources worldwide. Because the earth is the ultimate source of everything we need and produce, we must take good care of it.

RENEWABLE AND NON-RENEWABLE RESOURCES

Natural resources are divided into two major categories: renewable and non-renewable.

<u>Renewable resources</u> are those that grow and reproduce. Because they can regenerate naturally, supplies can be restored and if properly managed, maintained forever. Some examples of renewable resources include trees, plants, and wildlife. Many useful materials and products such as food, clothing, medicine, paper, and lumber are derived from these resources. After the raw materials are harvested, more can be planted or grown and over time the supplies will be restored. For example, if we harvest trees to produce paper, we can plant new seedlings. While the new trees are not exactly the same as those which were harvested, they add oxygen to the atmosphere, organic matter and nutrients to the soil, and provide food and shelter for many organisms. Renewable resources can be replenished, but excessive and improper use can severely deplete and ultimately destroy them. In general, we have the ability to consume resources more quickly than they can regenerate. Sophisticated technology and equipment exacerbate this problem as they enable us to harvest resources at rates which greatly exceed their natural ability to grow back, even with human assistance like replanting. Harvest and regrowth should be carefully balanced in order to maintain sustainable supplies of renewable resources.

Non-renewable resources are those resources that cannot be replaced. Some examples of non-renewable resources include precious metals, minerals, and fossil fuels. These raw materials are used as fuel, and to produce plastics, synthetics, glass, steel, and other useful items that are now part of our daily lives. Limited supplies of these materials are found on the earth. They must be carefully managed because once they are depleted, we will not be able to grow or cultivate new sources. Running out of items that have become necessities could significantly alter the way we live and have far reaching environmental ramifications. In addition, renewable resources such as trees depend on several non-renewable resources including minerals, soil, water, and air. All resources, including human beings, are connected in some way and are therefore interdependent. Destruction or depletion of one resource can trigger a chain of events leading to the breakdown of an entire ecosystem.

DEPLETION OF NATURAL RESOURCES

Natural resources are not equally distributed around the world. Thus, countries compete for rights and access to these valuable materials. As world population and the complexity of most societies increase, so, too, do the demands and pressures placed on natural resources. In addition, an increase in toxic materials entering the environment and polluting the water, air, and soil greatly threatens the integrity of existing resource reserves.

Excessive human consumption and mismanagement are destroying supplies of both renewable and non-renewable resources. Varying amounts of resources and energy are required to support different lifestyles. The U.S. and other industrialized nations require more energy and resources per capita than most other countries. Only 6 percent of the world's population lives in the U.S., yet we consume 33 percent of the world's energy. Much of this energy is used to meet industrial, residential, and transportation demands, which are viewed by many as excessive and inefficient. As a result, natural gas and oil are disappearing rapidly. It has been estimated that we will run out of these fossil fuels in the next 30 to 40 years, and that coal supplies will be exhausted by the year 2400. Unfortunately, fossil fuels are non-renewable resources and no amount of money or power will be able to replenish them or other limited supplies. Zinc, lead, and copper are also nearing depletion, while other non-renewable resources are expected to run out within the next century.

Poor management and excessive harvesting of renewable resources not only threatens that particular resource, but all those that depend on it. For example, trees are being harvested from tropical rain forests much faster than they can possibly grow back. Although in theory renewable with proper management, at present most tropical rain forest is being clearcut and burned and will probably never return to its original state. Ra id deforestation destroys valuable plant species, eliminates habitat and food sources fo many species of wildlife, and significantly reduces the amount of oxygen that the dense canopy of trees ordinarily emits into the atmosphere. The lush vegetation also provides organic matter and essential nutrients to the soil, while the complex root system holds it in place preventing soil erosion and flooding. Extensive logging is leading to rapid deterioration in soil fertility and significant increases in runoff, further decreasing the potential for successful regeneration. This example illustrates that poor resource management can have local as well as global ramifications.

CONSERVING NATURAL RESOURCES

Our convenience-oriented lifestyle not only consumes a great deal of natural resources but also wastes them. Many resources are converted to products with very short life spans. For example, using petroleum to produce plastic containers and packages designed to be discarded after only one use wastes valuable resources and adds to the growing solid waste stream. By putting these items in the trash, we are throwing away valuable resources.

There are, however, several steps we can take to conserve resources and protect the environment. The first step is becoming an educated and responsible shopper. As consumers, we have a lot of power over what types of products are and are not manufactured. One way to reduce the amount of resources used is to purchase fewer disposable products, especially those made from nonrenewable resources like petroleum. In addition, purchasing products in reusable containers can significantly reduce the amount of raw materials consumed. Reusing bottles, jars, bags, paper, etc., as many times as possible, prevents the resources used to make them from becoming trash. Finally, recycling as many items as possible helps conserve resources and protects the environment. Instead of using virgin raw materials, old glass, paper, metal, and plastic can be used to make new products. Using recycled materials in manufacturing, reduces the amount of energy needed in production as well as the amount of pollution generated.

Reducing, reusing, and recycling decrease both the demands on natural resources, as well as the rate at which they are consumed. Fewer resources are used, limited supplies are conserved, and regeneration of renewable resources can occur. In addition, less waste is generated, thereby reducing the amount of trash that must be landfilled or incinerated. As the amount of trash buried or burned decreases, so, too, does the potential for water and air pollution which can occur as the result of burning or improper disposal of wastes.

Natural resources must be conserved and properly managed to prevent depletion and contamination, and to ensure that people all over the world have access to those items necessary to maintain a decent standard of living. Choices we make in our personal lives can and do affect the environment. By reducing, reusing, and recycling, we can help conserve the earth and the life it supports for many generations to come.

ENDNOTES

1. U.S. Environmental Protection Agency. *Recycling Works! State and Local Solutions to Solid Waste Management Problems.* January 1989, Document #530-SW-89-014, p. 3.

2. Commonwealth of Massachusetts, Department of Environmental Protection. *The Commonwealth's Solid Waste Masterplan: Towards a System of Integrated Solid Waste Management,*" Second Draft, October 1989, p. 11.

3. *Ibid.*

4. Commonwealth of Massachusetts, Department of Environmental Management. *Household Hazardous Waste Brochure,* 1989.

WHAT IS WASTE?

THEME:	Trash is composed of a variety of items
GOAL:	Students will understand that trash is composed of basic materials
METHOD:	Guessing Game with discussion
SUBJECTS:	Language Arts
SKILLS:	Comparing, observing
MATERIALS:	Garbage can filled with clean trash representing all types of household waste: newspaper, cardboard, notebook paper, brown paper bag, cereal box (boxboard), magazine, glass bottle, plastic soda or milk bottle, plastic-coated cardboard milk or juice carton, plastic wrap, plastic six-pack ring, aluminum can, aluminum foil or tray, wax paper, styrofoam, disposable diaper, fabric pieces (natural and synthetic fibers), orange peel, chicken bone, leaves, twig, etc.; Ali Ka Zim rhyme on chart paper; wand
TIME:	45 minutes

GETTING STARTED

To get a sense of what the students think about trash, ask them what kinds of things they throw away. List their ideas on the board to later compare with what is in the sample trash can.

PROCEDURE

1. Invite students up one at a time to reach into the trash can while you recite the following rhyme and point to the words with your wand:

> Ali Ka Zim Ali Ka Zam
> What is (student's name) going
> To pull out of the can?

2. Have each child describe what the item they are touching feels like, without actually saying what it is. Have the other children try to guess what the item is and what it is made of.

3. Ask the children how they think the item is spelled and write it on the board.

4. After going through the entire contents of the can, compare the list of items with the one the students first made. Point out that trash often contains items that we might not ordinarily consider to be garbage.

EXTENSIONS

1. Hand out the attached worksheet, "A Smorgasbord of Trash." Have the children draw or cut pictures out of magazines for each of these items to create a trash dictionary. Make a bulletin board display illustrating examples of the same words.

2. Make a checklist of typical items a family might throw away in a week. (This might be the same as the worksheet list, or a shorter version.) Have the children mark an "X" next to an item every time they throw one out. Compare the students' tallies at the end of the week. Have them circle the ones that could have been recycled or re-used, rather than thrown out.

3. Learn the "I Love Trash" song from Sesame Street.

4. Have students complete the attached "Search-a-Word" puzzle to find the 16 words having to do with solid waste.

5. Have each student pick an item from the sample trash can. Have them write its life story: How was it made or grown? How was it used by its owner(s)? How was it consumed? How did it end up in the trash? What will happen to it now? Have the children draw pictures to accompany the story and put them together to make a book.

Sources: Adapted from *Oscar's Options*; Wisconsin *Recycling Study Guide*; Kristen Walser

A SMORGASBORD OF TRASH

Listed below are typical items found in many household trash cans. For each of these items, draw a picture or cut one out of a magazine and bind them together to make a trash dictionary.

paper plate

glass jar

aluminum can

plastic storage bag

corrugated packing box

styrofoam cup

newspaper

plastic milk carton

cardboard cereal box

styrofoam egg carton

plastic-coated cardboard milk carton

aluminum foil

orange peel or apple core

broken toy

grass clippings

brown paper bag

old rag

disposable diaper

plastic trash bag

junk mail

styrofoam packing material

plastic margarine tub

dead leaves

cardboard egg carton

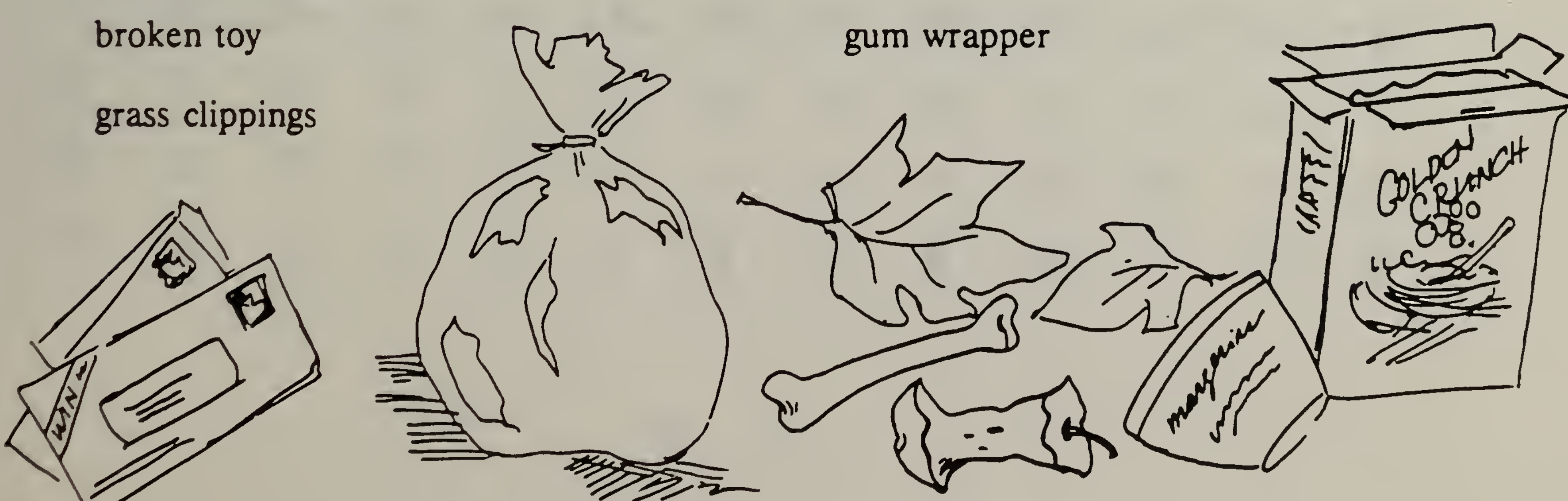
brick pack juice container

fast-food restaurant packaging

napkin

chicken bone

gum wrapper



SEARCH-A-WORD PUZZLE

The words listed below are hidden within the puzzle of letters. Some are spelled as you usually see them, but others are spelled backwards or on the diagonal. How many of them can you find?

RECYCLE	GLASS	LANDFILL	OIL
BOTTLE	TRASH	NEWSPAPER	CAN
PAPER	COMPOST	PLASTIC	
REDUCE	METAL	BATTERY	
ALUMINUM	ENVIRONMENT		

M	R	E	C	Y	C	L	E	H	Q	X	P	M
B	L	O	I	R	Z	A	L	T	I	M	E	U
Y	L	T	T	E	O	R	N	C	R	T	U	N
P	L	L	S	T	K	S	E	J	A	S	W	I
C	I	R	A	T	Q	U	P	L	V	T	C	U
O	F	G	L	A	S	S	P	A	K	Y	E	M
M	D	I	P	B	F	G	Y	A	M	D	U	L
P	N	K	O	T	R	B	E	W	P	U	D	A
O	A	M	C	W	P	I	T	Z	R	E	E	B
S	L	U	N	E	W	S	P	A	P	E	R	V
T	L	I	N	W	P	O	O	T	S	X	Y	N
T	N	E	M	N	O	R	I	V	N	E	L	A
P	T	I	N	R	C	E	L	T	T	O	B	D

WHEN IS IT TRASH?

THEME:	When is an object considered to be trash?
GOAL:	Students will consider when an object becomes trash and why careful and proper disposal is important
METHOD:	Discussion
SUBJECTS:	Language Arts
SKILLS:	Comparing, drawing conclusions, value judgement
MATERIALS:	None
TIME:	30 minutes

GETTING STARTED

Have the students start by reviewing the typical components of trash.

PROCEDURE

1. Ask the children what makes an item a piece of trash. For example, once a container of milk is empty, once they are finished reading the newspaper, once they have raked all the leaves off their lawn--are all these now trash? Have each child name a piece of trash and why they think it is no longer useable. What qualities do trash items have in common?

2. Ask the students why it is necessary to take trash to a special place (landfill or incinerator). Why not just leave it in their backyard or by the side of the road? Make a list of the children's responses (e.g., it is ugly, attracts animals, could catch fire, etc.)

3. Are there items that might be dangerous even if they are buried in a landfill or burned? Discuss hazardous items such as gasoline, radioactive chemicals, etc. Why are they harmful?

EXTENSIONS

1. Examine how other cultures use items that our society might consider to be trash.

TRASH CAN SCAN

THEME:	The waste stream is comprised of many different kinds of objects
GOAL:	Students will understand what garbage consists of and that it can vary in composition over time or by location of collection
METHOD:	Classify, weigh, and graph represent the composition of the classroom's trash
SUBJECTS:	Language Arts, Math
SKILLS:	Analyzing, comparing
MATERIALS:	"Municipal Solid Waste in Massachusetts" handout; three days worth of classroom trash; scale capable of weighing in ounces or grams; construction paper and/or graph paper
TIME:	One hour per day for several days

GETTING STARTED

Ask students what kinds of things they throw away. What are they made of? Find out what materials they think makes up most garbage.

PROCEDURE

1. Distribute the "Municipal Solid Waste in Massachusetts" handout. Discuss the different categories of trash (paper, plastic, metal, etc.), and list examples of items in each category. Students can create trash category posters or collages using these lists and drawings or pictures from magazines and newspapers.

2. Collect all trash discarded by the class for several days. Lay a sheet on the floor, dump the trash on it, and let the students sort it according to category, i.e., paper, plastic, metal. For items that can fit into more than one category, have them decide which one is predominant. If many items are equally mixed, you might want to create a mixed materials category. Working in groups, have the students weigh a category of trash and record their results on the blackboard.

3. Have the students create a bar chart bulletin board display which compares the various components of the classroom waste stream. Each material can be represented by a different colored construction paper bar. Determine the scale to be used (e.g., two vertical inches equals one ounce).

4. Repeat this activity for three separate trials, each time separating and weighing the trash, recording the data, and constructing a bar chart. Students may also calculate the three-trial average. Have the class graph the results.

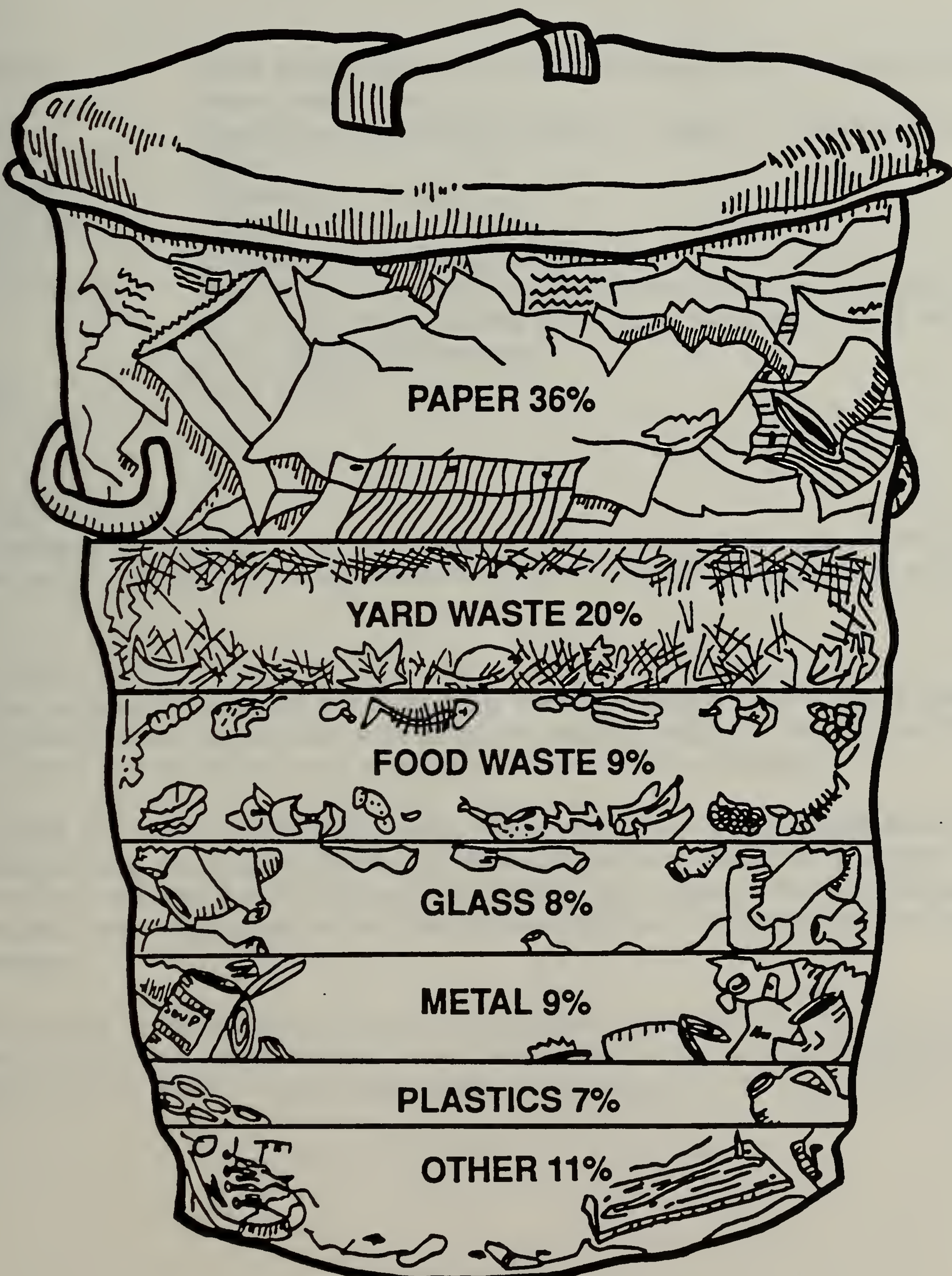
5. Compare your classroom results to the figures on the handout. What are the differences and similarities? Did the time of week when the trash was collected affect the results? Why?

EXTENSIONS

1. Discuss the difference between amount in weight and amount in volume. Would the category that is the heaviest also take up the most space in the trash can or at the landfill?

2. Have the different groups survey trash cans from other areas of the school (other classrooms, the library, the gym) or home, and compare the results with those obtained in your classroom. Does the composition of the waste stream vary at each location? If so, why? Discuss differences and similarities of the trash from different locations. Predict the results of this type of trash analysis using the garbage from department stores, supermarkets, factories, and other institutions. What would be some of the differences and similarities in the composition and amount of waste? Why?

Municipal Solid Waste in Massachusetts, By Weight



Source: Franklin Associates Ltd.

TYPES OF WASTE: PRODUCT PROFILES

THEME:	Trash can be divided into basic categories of materials (glass, metal, paper, plastic, etc.)
GOAL:	Students will identify the different categories of materials found in trash
METHOD:	Classification of objects
SUBJECTS:	Science
SKILLS:	Comparing, classifying, interpreting
MATERIALS:	Trash items (cleaned and rinsed); several cardboard boxes, labelled by category (paper, metal, etc.); labels for plastic, wood, paper, food, metal, and glass; tape
TIME:	30-45 minutes

GETTING STARTED

Ask students to think about the composition of different items of trash. Have them name various categories of materials (plastic, food, etc.) and an example of each.

PROCEDURE

1. Line up a set of boxes on the front desk, one per category. Each should have a label--metal, plastic, paper, etc.--with an accompanying sample or illustration. Give the class a brief explanation of each category and show them an example.

2. Divide the students into small groups. Give each group a set of trash items which includes at least one example from each material category, and a set of labels. Have the students sort and label the objects by material type. Some items may be made of more than one type of material and the students will need to decide which is the most prominent.

3. When the students have finished classifying their objects, ask each group to deposit them in the correct cardboard box in the front of the room. List the trash items by category on the board. Which category has the most items? the least number of items?

EXTENSIONS

1. Make a bulletin board display of a trash can. Cut out the shapes of different trash items and label them, using the same colored paper for each category of material.

2. Set up a scavenger hunt in the classroom. Give each child or team of children a category of material. Tell them that within a certain time limit they have to find an object in the room which is made from it and label it by material type. Which category has the most items in it?

3. Set up the category boxes in one corner of the room. Have the students separate everything they throw away into the appropriate container. At the end of one week go through the boxes and look at the different types of items under each category. Could some items be classified under more than one group? Which category had the largest number of items? Which category of items took up the most space?

4. Divide the class into teams, each representing a different category of materials. Have each team develop a list of everyday items made from their material. For example, the plastics group might include dishes, hairbrush, toys, etc. Have each team keep a daily log of the items they use made out of their material. Compare the lists between teams and discuss how important each of these categories of materials is to our society.

Source: Kristen Walser

KNOW YOUR PROPERTIES

THEME:	Basic materials have different properties
GOAL:	Students will understand the properties of basic materials
METHOD:	Classification of objects
SUBJECTS:	Language Arts, Science
SKILLS:	Comparing, drawing conclusions, observing
MATERIALS:	Boxes of trash separated by type of basic material (See "Types of Waste: Product Profiles" activity); chart paper
TIME:	45 minutes

GETTING STARTED

Ask the students what are the properties or characteristics of basic materials. How might these affect what the materials are used for and how they are disposed?

PROCEDURE

1. Line up the boxes of separated trash (paper, metal, etc.) and have the children sit in a semi-circle around them. Take an object out of one of the boxes and pass it around. Ask the students to describe it: what it looks and feels like, and different uses for it. Write the words on the board, using a different column for each category of material. For example, under glass might appear descriptions such as hard, breakable, clear, smooth, colored, holds water, round, etc. In a second column list the opposite characteristics (e.g., soft, unbreakable, opaque, rough, clear, porous, square, etc.). Repeat for different items in each of the categories.

2. Break the students into pairs and assign each group one set of opposite characteristics. Give each pair a set of trash items to sort into one of two piles based on their given characteristic or its opposite (e.g., breakable and non-breakable, rough and smooth, etc.).

3. Do any patterns emerge? Is all the glass in the "round" pile? most of the metal in the "shiny" pile? Why?

4. Draw conclusions about how the properties of objects affect how they are made and how they are used. For example, ask students why manufacturers don't put soda in paper bags or print newspapers on metal.

EXTENSIONS

1. Make a list of the basic characteristics--breakable, smooth, porous, etc. Have students categorize other items found around the classroom by these characteristics. Do they fit the same patterns discovered above?

2. Put a variety of trash items in a large bag. Without looking at the item, have each student reach into the bag and use their sense of touch to determine if it is made out of glass, metal, plastic, etc. Have them tell the other students how they made their decision.

3. Make a bulletin board display of the new vocabulary words describing the properties of items, grouped by opposites. Have the students cut pictures of out magazines illustrating examples which fit under each characteristic and its opposite. For example, under "round" they might display a picture of a bottle and a windowpane.

4. Introduce the concept of magnetism and what magnets can reveal about the basic properties of metals. Explain how magnets can be used to tell whether or not a can is made out of aluminum. Using magnets, have the students test out other metal objects in the classroom. How might magnetism be used to sort metals that are brought to the recycling station?

Source: Kristen Walser

SIZING UP WASTE: VOLUME vs. WEIGHT

THEME:	Composition of trash by volume and weight can be very different
GOAL:	Students will learn the concepts of volume and weight and how different types of trash affect the quantity of solid waste produced
METHOD:	Classification and weighing of items
SUBJECTS:	Math
SKILLS:	Comparing, counting, drawing conclusions, measuring
MATERIALS:	Can of trash collected in the classroom for one week OR sample can of trash items prepared in advance; scale; graph paper
TIME:	One hour

GETTING STARTED

Ask the students if all the items they throw away are the same size and weight. Have them name some examples that are small, large (bulky), light, heavy, etc. Ask the students to predict which materials make up the greatest portion of waste by volume, by weight, and by number of items.

PROCEDURE

1. Using the trash collected in the classroom for a week or a sample trash can of items prepared in advance, have the students separate it into the different categories of materials--glass, plastic, paper, metal, etc.

2. Ask the students which category of items they think is the heaviest? Which takes up the most room? Which contains the greatest number of pieces? Have the students write down their answers in order of heaviest to lightest, bulkiest to most compact, and most to least numerous.

3. Weigh each category of items. For the paper category, material could be divided into newspaper, cardboard, writing paper, and other. Then place the objects in a clear container and determine their volume by measuring how much space they occupy (width, depth, and height). Finally, count the number of items. Make a chart on the board showing the weight and volume of each category. Do the heaviest items also take up the most room?

4. Discuss how weight and volume of trash are both important in its disposal. Bulky items may not weigh much, but may take up more space in the landfill or trash compactor. How might the volume change if glass, cans, or boxes are crushed? Does the weight change if the volume changes?

EXTENSIONS

1. Extend the exercise by asking what other sorts of items are thrown away that were not represented in the trash can: yard wastes, white goods (refrigerators, washing machines), etc. Where do they fit into the spectrum?

2. Make a bulletin board display using different colored blocks to represent each part of the waste stream. Make one trash can showing the trash content by weight, another showing trash content by volume, and a third showing trash content by number of items. For each category of waste, cut out a band of paper representing its percentage of the total, so that when stacked one above the other, the three trash cans are full. What are the implications of these differences in terms of waste disposal?

3. Have students repeat the exercise at home. Give each student a set of paper bags and label them paper, plastic, glass, etc. For one or two weeks, tell the children to put everything they discard into the appropriate bag. Compare the results among the children and to those derived from the classroom trash. Which category of items differs the most? Why?

BE A GARBAGE DETECTIVE

THEME:	Humans produce a lot of garbage but are often unaware of what happens to their waste
GOAL:	Students will define waste and consider the implications of throwing something away
METHOD:	Creating pictures as a basis for discussion and story telling
SUBJECTS:	Art, Language Arts, Science
SKILLS:	Comparing, drawing, inferring, researching
MATERIALS:	Drawing paper; magazines
TIME:	One to two hours

BACKGROUND

All living creatures produce some sort of waste, but their ways of disposing of it vary greatly. Humans are very wasteful compared to other creatures on earth. Often we are unconcerned with what happens to our waste and unaware of the impacts it can have on the environment. By looking at how animals and plants minimize the amount of waste they produce, as well as the ways in which they deal with their garbage, we can learn some important lessons about efficiency and waste disposal.

GETTING STARTED

Ask the students to think about their house and about the kinds and amount of garbage their families produce. What do they do with their garbage? What do they think happens to it?

PROCEDURE

1. Ask each student to draw two pictures: one of his/her house and the other of an "animal's house." Have the students share their pictures with the class and start a discussion on where garbage fits into each picture. What is garbage? Do animals have garbage? Who produces more garbage, people or by animals? What are some differences and similarities between waste generated by people and animals? Why do people throw away so much more than animals? How do people get rid of their garbage? Where does it go? What could people do to be more like animals regarding the production and disposal of waste?

2. Have the class create a story about the pictures they have drawn. Write it on the blackboard for the students to read and/or copy down and attach to their pictures.

3. Have the children go through magazines and cut out pictures of items that are usually thrown away after one use to create a poster or collage. Start a discussion about the kinds of items on the posters. How could we avoid throwing away so many of these things? During this discussion review the following questions: What is garbage? Where does it come from? Why do people create more waste than other animals? Is this a problem? What can we do about it?

EXTENSIONS

1. Have the students research an animal of their choice to learn about its habitat, way of living, the kinds and amount of waste it produces, and its methods of dealing with this waste. The children could write and illustrate stories based on what they have learned and present them to the class.

Source: Reprinted with permission from *A-Way With Waste*

ONE PERSON'S GARBAGE CAN IS ANOTHER'S GOLD MINE

THEME:	Some components of the waste stream are valuable resources; by reusing them we can help solve some of our solid waste disposal problems
GOAL:	Students will re-examine waste as a resource by looking at other uses for it
METHOD:	Reading and discussion
SUBJECTS:	Language Arts, Social Studies
SKILLS:	Inferring, listening, predicting, reasoning
MATERIALS:	Excerpts from *Stuart Little* and *Charlotte's Web*; drawing and writing paper
TIME:	One hour (longer if children write their own stories)

BACKGROUND

The terms waste and resource are relative and reflect our own needs and values rather than any objective quality of an object. How we feel about garbage has a lot to do with how we take care of it. Some items that we might ordinarily consider worthless (garbage), may prove to be very useful to another individual, family, company, or industry. By changing our perceptions of trash and discovering alternative uses for it, we can prevent valuable resources from being wasted and reduce the amount of solid waste that needs to be landfilled or incinerated.

GETTING STARTED

Ask students what they think of when they hear the word garbage? Have them describe their feelings.

PROCEDURE

1. The children will probably have a negative reaction to the previous question. Explain that the class is going to read about someone who feels the same way they do about trash. Stuart Little is a mouse who lives in the city and is always getting into trouble. This passage relates one of Stuart's misfortunes, when he accidentally gets caught in a garbage can. Read the following quote from *Stuart Little*:

The men threw the can with a loud bump into the truck, where another man grabbed it, turned it upside down, and shook everything out. Stuart landed on his head, buried two feet deep in wet slippery garbage. All around him was garbage, smelling strong.

Under him, over him, on all four sides of him--garbage. Just an enormous world of garbage and trash and smell. It was a messy spot to be in. He had egg on his trousers, butter on his cap, gravy on his shirt, orange pulp in his ear, and banana peel wrapped around his waist.

Still hanging onto his skates, Stuart tried to make his way up to the surface of the garbage, but the footing was bad. He climbed a pile of coffee grounds, but near the top the grounds gave way under him and he slid down and landed in a pool of leftover rice pudding. "I bet I'm going to be sick at my stomach before I get out of this," said Stuart.

2. Discuss how Stuart felt about garbage. Why didn't he like it? Explain to the class that what was unpleasant for Stuart might be a field day for someone else. Read the following quote from *Charlotte's Web*:

Lurvy dragged Wilbur's trough across the yard and kicked some dirt into the rat's nest, burying the broken egg and all Templeton's other possessions. Then he picked up the pail. Wilbur stood in the trough, drooling with hunger. Lurvy poured. The slops ran creamily down around the pig's eyes and ears. Wilbur grunted. He gulped and sucked and gulped, making swishing and swooshing noises, anxious to get everything at once. It was a delicious meal--skim milk, wheat middlings, leftover pancakes, half a doughnut, the rind of a summer squash, two pieces of stale toast, a third of a gingersnap, a fish tail, one orange peel, several noodles from a noodle soup, the scum off of a cup of cocoa, an ancient jelly roll, a strip of paper from the lining of the garbage pail and a spoonful of raspberry jello.

How did Wilbur feel about garbage? Point out that Wilbur's garbage was useful and not wasted. Our own garbage can also be a resource. Brainstorm some possible uses for our trash including composting, feeding food waste to pet pigs or rabbits, building tree houses or scooters out of construction debris, fixing broken toys or using the old parts to make new ones, etc.

EXTENSIONS

1. Bring the children back to *Stuart Little* to find out what happens to him.

There was no way for him to get out of the truck, the sides were too high. He just had to wait. When the truck arrived at the East River, the driver drove out onto the pier, backed up to a garbage scow, and dumped his load. Stuart went crashing and slithering along with everything else and hit his head so hard that he fainted and lay quite still, as though dead. He lay that way for almost an hour, and when he recovered his senses, he looked about him and saw nothing but water.

The scow was being towed out to sea. "Well," thought Stuart, "this is about the worst thing that could happen to anybody. I guess this will be my last ride in this world." For he knew that the garbage would be towed twenty miles out and dumped in the Atlantic Ocean.

2. Discuss what happens not only to Stuart but to all garbage. Are they really going to dump it in the ocean? What effect will this have on the water and on the creatures living in it? Brainstorm positive alternatives which would treat garbage as a resource, as in *Charlotte's Web*. Mention that in addition to individuals using garbage as a resource, companies and industries can use it to manufacture useful products. For example, crushed glass can be used in street pavement to increase reflectivity.

3. Have students create their own adventure stories about an animal or another character and solid waste.

4. Create drawings, posters and/or a bulletin board display of the alternative uses for garbage that the class came up with during the discussion.

Sources: Reprinted with permission from AVR *Teacher's Resource Guide*; *excerpts reprinted with permission from Charlotte's Web* and *Stuart Little* by E.B. White.

WASTE NOW...WORRY LATER

THEME:	Wasteful habits have negative impacts on the earth and its inhabitants
GOAL:	Students will examine the concept and implications of waste
METHOD:	Reading and discussion
SUBJECTS:	Language Arts
SKILLS:	Drawing, inferring, interpreting, listening, writing
MATERIALS:	"Why People Have To Work," an Afro American folktale
TIME:	45 minutes

GETTING STARTED

Ask students what they think it means to be wasteful?

PROCEDURE

1. Consider using the medium of storytelling or reading aloud to present the attached folktale, or have the students read it and/or act it out.

2. What made the sky so mad? Why did the people waste the sky? What is something that we waste? Ask the students why they think we waste things. What can we do to avoid wasting important materials or resources?

EXTENSIONS

1. Have the students write down what they remember of the folktale and illustrate their own version of the story.

2. Have the children write and illustrate their own stories about items that we waste and what might happen if we continue to do so.

Source: Kristen Walser

WHY PEOPLE HAVE TO WORK

The sky use to be very close to the ground. In fact, it wasn't any higher than a man's arm when he raised it above his head. Whenever anybody got hungry, all they had to do was to reach up and break off a piece of the sky and eat it. That way, no one ever had to work.

Well, it was a fine arrangement for a while, but sometimes people would break off more than they could eat, and what they couldn't eat they just threw on the ground. After all, the sky was so big there would always be enough for everybody to eat. What did it matter if they broke off more than they actually wanted?

Maybe it didn't matter to them, but it mattered to the sky. In fact, it made the sky angry to see itself laying on the ground, half-eaten, like garbage. So one day the sky spoke out and said, "Now look-a-here! Can't have this! Uh-uh. Can't have you people just breaking off a piece of me every time your stomach growls and then taking a little bite and throwing the rest away. Now if y'all don't cut it out, I'm going to move so far away no one will ever touch me again. You understand?"

Well, people got the message. In fact, they were pretty scared, and for a while they made sure that no one ever broke off more sky than they could eat. But slowly they began to forget. One day, a man came by and broke off a chunk big enough to feed forty people for a month. He took a few little bites, looked around the edges, threw the rest over his shoulder, and walked on down the road just as happy and dumb as anything you've ever seen. Well, the sky didn't say a word, but with a great roar, the sky lifted itself up as high as it could, and that was pretty high.

When people realized what was happening, they began crying and pleading with the sky to come back. They promised that they would never do it again, but the sky acted like it didn't hear a word.

The next day, the people didn't have a thing to eat, and that's why people are working to this very day.

Source: Reprinted with permission from *Black Folk Tales* by Julius Lester, published by Grove Press, New York, NY (c), 1969.

HAZARDS AT HOME

THEME:	Some products are hazardous and remain so even after they are put in the trash
GOAL:	Students will learn that some products are poisonous and harmful to humans as well as to the environment
METHOD:	Puppet show or teacher demonstration
SUBJECTS:	Science, Theatre
SKILLS:	Analyzing, communicating, value judgement
MATERIALS:	Two puppets; cardboard box approximately 1-1/2 foot square; pictures or containers of hazardous products: oven and drain cleaners, auto cleaners, paint thinner, varnish, used motor oil, gasoline, etc.
TIME:	30 minutes

GETTING STARTED

Introduce the concept of poisons. Ask the children if they know what it means if something is poisonous and if they can name some examples of poisons. Why would someone eat a poisonous product?

PROCEDURE

1. Explain to the students that some things that are used for cleaning, painting, killing unwanted bugs or plants, and maintaining cars can hurt them and other living creatures. Many can be harmful if eaten, inhaled, or touched.

2. Set up a stage on a front desk.

3. Introduce puppets, Rebecca Rabbit and Rocky, and tell the children they have a story to share with them. If possible, have two different adults act the two parts.

(Play Begins)

Rebecca: Hi Rocky! How are you?

Rocky: Funny you should ask. I had to go the hospital last week. My stomach still doesn't feel very good.

Rebecca: Too much candy again, Rocky?

Rocky: Not exactly. I was having a good time playing house and ate something I found under the kitchen sink. It looked like something my Mom spreads on crackers at her parties...It made me very sick and I still have to eat special foods. At the hospital they told me that there are a lot of things in my house which are dangerous to eat, smell, and touch.

Rebecca: Really? (Rebecca looks in her cupboard (a cardboard box with a door) and pulls out containers or magazine pictures representing various household hazardous substances. For each item she asks the students what it is used for and whether or not it is hazardous. Rephrase the questions by interchanging the words hazardous, poisonous, toxic, harmful, could make you sick, etc.) After looking over all the objects, Rocky notes: "There are a number of items that are toxic at my house, too."

Rebecca: Well, forget it! If these things can make me sick then I don't want them in my house. (Rebecca starts to throw the hazardous materials in the trash, but is stopped by Rocky)

Rocky: Don't throw them in the trash, Rebecca! These things are also dangerous there. If they get buried at the dump, rain water can run through them and carry the poisons into our drinking water, or an animal could eat them.

Rebecca: Okay. I'll pour them down the sink instead.

Rocky: Don't do that, Rebecca! If you pour them down the sink they will go to the treatment plant where they try to clean the water. But these poisons can't be cleaned very well so they'll end up in the river or the marsh.

Rebecca: The river? That could hurt a number of my friends who live there if they were to drink the water. Let's see, there are the Scales, a fish family, and the Quacks--you know that nice family of ducks and their cousins from Canada, the Honkers. (To the audience) Do you know anyone who drinks water from the river?

Okay, I won't pour them down the drain. I know what, I'll send them to the incinerator where they can be burned and get rid of them that way.

Rocky: Sorry Rebecca, but that is just as bad. The toxins will then end up in the air or in the ground when the ash remains are buried. Burning it doesn't make it less dangerous.

Rebecca: What can I do, Rocky?

Rocky: Have your parents save these items in a safe place until your town has a hazardous waste collection day. People will come and carefully collect the poisonous materials in special containers and take them away to places where they can be disposed of safely. Some can be burned in special ovens, while others, like used motor oil, can be reprocessed into new oil, saving energy and reducing pollution.

Rebecca: That sure sounds better than putting these harmful things in the water.

Rocky: It sure is, but do you know the best thing you can do?

Rebecca: What?

Rocky: Find substitutes to use in place of these toxic materials. There are a number of things you can use to clean with that are not hazardous. I make up a mixture of soapy water to kill the bugs on plants, and use baking soda and water to clean the oven. Then no one has to worry, not the Scales nor the Quacks, not you and not me!
Rebecca: Thanks for telling me what to do about toxins, Rocky. But next time you want to learn something, please ask somebody about it. Don't just eat anything you find around your house. Promise?

Rocky: I promise

Rebecca: I like you, Rocky

Rocky: I like you too, Rebecca

THE END

EXTENSIONS
1. Have the students make their own versions of the "Mr. Yuk" sticker and bring them home to put on hazardous items.

2. Send home with students the attached handout on household hazardous wastes ("Poisons in the Home") to discuss with their families. Have students make a batch of non-toxic cleaner to bring home for their parents.

3. Make a bulletin board display, having children cut out pictures of products they think might be hazardous and ones that are not. Have the children discuss why or why not they think the item is harmful.

4. Give students a list of items commonly found around home that may be toxic. Many of them are used to make things cleaner or to make our lives easier. The list might include paint thinner, oven cleaner, bathroom scouring powder, bleach, weed or bug killer, nail polish, turpentine, etc. Have the students draw a picture of a house and label where these items might be found. Discuss what precautions should be taken with these items. Have the students write a class letter to their parents telling them what they have learned about household hazardous wastes and asking for their help in identifying them at home.

Source: Kristen Walser

POISONS IN MY HOME?

Take a Closer Look

What Are Household Hazardous Materials?

Household hazardous materials are chemically-based products which can be dangerous to human health and to the environment.

Cleaning Products:	ammonia, spray cleaners, window and rug cleaners, furniture and metal polishes, drain cleaners
Garden Supplies:	weed and insect killers, fertilizers, gasoline, charcoal lighter fluid
Auto Supplies:	antifreeze, motor oil, transmission fluids, cleaners, waxes, gasoline, batteries
Paint Supplier:	Furniture refinishers, turpentine, oil-based paints, paint and varnish removers, caulking and sealing products, waxes and glues
Laundry Aids:	bleaches, starches, detergents, spot removers
And More...	swimming pool chemicals, photographic chemicals, craft and hobby supplies

How Do I Know if a Product is Hazardous?

Read the label of the product for words such as: warning, poison, caution, harmful, flammable, caustic.

What Are The Problems Created By Improper Disposal Of Household Hazardous Materials?

1. Pouring hazardous materials in your backyard can kill vegetation, harm children and pets, and seep through the soil to the groundwater below.

2. When hazardous materials are poured into sewers they often seep through the cracks into the ground and the groundwater. When storm sewers drain into rivers, lakes, and streams, hazardous materials flow directly into the water.

3. Hazardous wastes poured down the drain flow through sewer pipes and finally into sewage treatment plants. Most sewage treatment plants cannot remove hazardous materials from wastewater or from other solid material. Hazardous wastes poured down the drain into septic tanks flow into leaching fields and eventually into the groundwater. If a water well or spring is located nearby, it is possible to draw hazardous materials into the well.

4. Hazardous materials thrown into the trash often cause fires and release fumes inside the collection truck. Workers can be injured by these fires and fumes, or by being splashed with hazardous materials.

5. Hazardous materials not thrown into the trash often end up in the local landfill. Containers break, materials melt together, and rain and melting snow cause materials to seep into the ground and eventually reach the groundwater below.

6. Hazardous materials thrown into the trash often end up in the municipal incinerator. Most municipal incinerators do not burn at a high enough temperature to destroy the toxic components of materials. As a result, hazardous pollutants are released into the air.

How Should Household Hazardous Materials Be Disposed Of Safely?

1. The only really safe place to dispose of household hazardous materials is to store them until your community participates in a hazardous waste collection day. A licensed hauler will collect the material and take it to an environmentally-safe hazardous waste disposal facility.

2. If you have a commercially available product which you are no longer going to use, pass it along to a friend or co-worker who has use for the product.

3. The contents of aerosol cans should be released before the cans are thrown into the trash.

4. Waste oil should be brought to a waste oil recycling center, or returned (with sales receipt) to the place of purchase.

Sometimes It Is Necessary To Use Hazardous Materials In The Home. How Should These Products Be Safely Used And Stored?

Safe Usage:

1. ALWAYS read and follow the directions on the label. It will tell you about safe use, disposal, and emergency measures in case of an accident.

2. Always use proper safety equipment such as rubber gloves, safety glasses, or a face mask.

3. NEVER mix chemicals. It is possible to create an extremely hazardous chemical by mixing unknown materials. Bleach and ammonia, for example, form a deadly gas.

Safe Storage:

1. Store hazardous materials on a high shelf or in a locked cabinet, away from children and pets.

2. Always store hazardous materials in a labelled container. It is too easy to forget what material was put in the container.

3. Never store hazardous materials in a container previously used for another purpose. Children who cannot read can recognize familiar containers.

4. Never leave hazardous materials out in the open and unattended.

Source: Reprinted with permission from For a Cleaner Environment (F.A.C.E.), Woburn, MA

ALTERNATIVE BINGO--THE SAFER WAY TO PLAY

THEME:	Many common household and garden products are toxic and can be replaced by safer alternatives
GOAL:	Students will become familiar with less toxic substitutes for poisonous home and garden products
METHOD:	Bingo game
SUBJECTS:	Language Arts, Health, Science
SKILLS:	Inferring, problem solving
MATERIALS:	Bingo grid; master cards; "Safer Alternatives" handout; a container; ten markers per student (beans, pennies, paper clips, etc.).
TIME:	45 minutes

GETTING STARTED

Ask the students if they think there are any poisonous substances at their house. Do their parents use any toxic materials when they work around the house or in the garden? If so, could they use anything else to do the same job?

PROCEDURE

1. Discuss the meaning of toxic and poisonous with the children. Point out that many items we use are poisonous and could harm us and the environment. Give some examples such as drain cleaners, paint thinner, flea dip, oven cleaners, etc. Point out that these toxic materials are usually expensive and that cheaper and safer alternatives often work just as well.

2. Distribute the "Safer Alternatives" information sheet and go over it with the students. Ask them if they are surprised by anything they see on the list. Have they seen any of the items used in their homes? Can the children think of additional items to put on the list? Do they think that their families would be willing to try some of the suggested alternatives? Which ones? Why? Why not? Brainstorm ways in which safer alternatives could be made more convenient.

3. Distribute a Bingo grid to every student. Each student should fill in the grid by randomly writing one of the headings listed on the safer alternatives sheet in each box (e.g., aerosol sprays, ant control, drain openers, etc.) No phrase or heading should be used more than once. Give each student ten markers.

4. Cut up the master cards and place them in the container. Draw one master card from the container and call out the substance. Students may place one marker over a toxic substance on their grid which can be replaced by the alternative called. For example, if the teacher calls out baking soda, the students may place a marker over oven cleaner, scouring powder, or deodorizer. They may choose any of these substances but may use only one marker per turn. Students should be encouraged to refer to the "Safer Alternatives" sheet for help. Marking four toxics in a row horizontally, vertically, diagonally, or in the four corners of the grid, wins the game. Students may exchange grids for additional games.

EXTENSIONS

1. Have the students create illustrations, jingles, or skits advertising or promoting a safer alternative.

2. Have the students compare the costs of toxic products with an appropriate safer substitute. This may be done in pairs at a local supermarket (make sure to get permission from the store manager), or at home with their parents. Have the students record their findings on a chart and bring them to class for comparison and discussion.

Source: Reprinted with permission from *Oscar's Options*

ALTERNATIVE BINGO

Source: Reprinted with permission from *Oscar's Options*

MASTER CARDS

Cut each rectangle and place in a container.

LEMON JUICE AND VEGETABLE OIL	PAN WITH BEER
PUMP-STYLE SPRAY	MAYONNAISE AND SOFT CLOTH
OPEN WINDOWS FOR FRESH AIR	PLUNGER/PLUMBER'S SNAKE
HOT VINEGAR SET IN A DISH	SALT ON SPILLS
BAKING SODA	WATER-BASED PAINT
FRESH CUT FLOWERS	OVERTURN CLAY POTS
DRIED FLOWERS WITH SPICES	COMPOST
GRATED LEMON RIND	SCREENS
STEEL WOOL	CREAM OF TARTAR
MECHANICAL MOUSE TRAPS	BIODEGRADABLE SOAP
SOAP AND WATER	VINEGAR AND SALT
EUCALYPTUS LEAVES	BREWER'S YEAST

Source: Reprinted with permission from *Oscar's Options*

SAFER ALTERNATIVES FOR TOXIC PRODUCTS

The following is a list of safer substitutes for some household toxics. Generally these products can be purchased in any grocery store.

AEROSOL SPRAYS
* Use pump-type sprays whenever possible to replace aerosols (e.g., hair sprays)
* Use fresh flowers or sachets of dried petals mixed with spices instead of room sprays

ANT CONTROL
* Sprinkle cream of tarter in front of the ant's path. (Ants will not cross over it.) Cream of tarter is a substance used in baking

BUG SPRAY
* Place screens on windows and doors.
* Brewer's yeast tablets taken daily give the skin a scent that mosquitos seem to avoid

CHEMICAL FERTILIZERS
* Compost

COPPER CLEANER
* Pour vinegar and salt over copper and rub

DEODORIZERS & AIR FRESHENERS
* Open windows or use exhaust fans as a natural air freshener
* A dish of hot vinegar can get rid of fish odors
* Baking soda placed in the refrigerator reduces odors
* Fresh cut flowers or dried flower petals and spices can add a nice scent to a room; boiling potpourri or cinnamon and cloves in water will also produce a nice scent

DETERGENTS (LAUNDRY & DISHWASHING)
* Replace detergents with soaps that are relatively "non-toxic" and biodegradable; to wash out residues from detergents, pre-wash in washing soda

DRAIN OPENERS
* Pour <u>boiling</u> water down the drain. DO this every week for preventative maintenance
* Use a plumber's helper (plunger) or a plumber's snake

FLEA REPELLENT
* Place eucalyptus seeds and leaves around the area where the animal sleeps

FLOOR CLEANERS
* Use soap and water
* Use washing soda and water

FURNITURE POLISH
* Use a soft cloth and mayonnaise
* Mix one part lemon juice and two parts vegetable oil

GENERAL CLEANERS (ALL PURPOSE CLEANSERS)
* Mix three tablespoons washing soda in one quart of warm water
* Use baking soda with a small amount of water

GLASS AND WINDOW CLEANERS
* Use cornstarch and water
* Mix one-half cup of vinegar and one quart warm water; wipe with newspapers
* Use lemon juice and dry with a soft cloth

OVEN CLEANERS
* Mix three tablespoons of washing soda with one quart of warm water
* Place liners in oven to catch any drips during baking
* Sprinkle salt on spills when they are warm and then scrub
* Rub spills gently with steel wool

PAINT
* Water-based paints are less toxic than metal-based paints, and require no solvent for clean-up

RAT POISON
* Put a screen over drains
* Use mechanical snap mouse and rat traps

SCOURING POWDER
* Dip a damp cloth in baking soda and rub
* Use steel wool

SNAIL & SLUG BAIT
* Place a shallow pan with beer in the infested area
* Overturn clay pots; snails take shelter in them during sunny days and thus can be collected and removed

Source: Reprinted with permission from *Oscar's Options*

THE RESOURCEFUL EARTH

THEME:	Everything comes from the earth
GOAL:	Students will trace objects from their source and learn that everything we use is made from raw materials that come from the earth
METHOD:	Skit of the manufacturing process
SUBJECTS:	Science, Theatre
SKILLS:	Classifying, drawing conclusions, interpreting
MATERIALS:	Two cardboard boxes large enough for a child to fit through, with entry and exit doors cut out; string; selection of different trash items; cards labeled with headings: Minerals/Oil, Minerals/Rock, Plants, or Animals
TIME:	One hour

BACKGROUND

Natural resources are the source of everything we make, use, and throw away. Some raw materials are used in their natural state (e.g., wood), while others are chemically altered. Many of these materials took millions of years to form. Current rates of human consumption and trash generation are starting to rapidly deplete many of the earth's natural resources.

Raw materials fall into two categories: renewable and non-renewable. Renewable resources can be slowly replaced if they are managed wisely. Trees cut down to make paper or lumber can be replanted to ensure a continuous supply of wood. Other resources, however, are found in limited quantities; once the current supply is gone no more is available. Once the earth's deposits of oil or copper run dry, no more can be grown. These are called non-renewable resources.

GETTING STARTED

Repeat the Ali Ka Zim rhyme from the "What is Waste?" activity while having each student pull an object out of the trash can. Ask the child into which category of basic materials the item fits (glass, metal, etc.) and to name one characteristic of it.

Discuss with the students the concepts or renewable and non-renewable resources. What are some examples of each?

PROCEDURE

1. Select an object from the trash can, for example, a glass bottle. What is glass made from, and how? Explain that it is made of sand, soda ash, limestone, and feldspar, the purpose each of these components serves, and where they come from. Note that energy is used to melt the materials which are then blown or molded into different shapes. Repeat this exercise with examples from each of the basic categories.

2. Tell the children they are going to play a game called "Factory." Arrange the two large boxes side by side at the front of the room. Label one "Oven" and the other "Sawmill." Attach a string from the boxes to an electric pole drawn on the board to represent the use of energy in making goods. Explain that there is a separate factory for the wood because it is shaped by cutting rather than by melting. Select one student to be the factory operator and another to be a miner or logger. Hand the remaining students a file card representing one of the four resource groups: Minerals/rock, minerals/oil, plants, or animals.

3. The game starts with the miner "digging out" a certain type of mineral or the logger "cutting down" a tree. The miner/logger brings the "raw material" to the factory (oven box or sawmill) and tells the class which of the four resource groups it represents (based on the card given to each student). The child then goes through the factory (box). Upon emerging from the other side the student should say what type of basic material they were made into (glass, metal, paper, etc.) and name one use for the product they have become. Hand the child an example of the object they suggested or write it on a card for them to hold.

4. After all the children have gone through the factory, ask them where they can get more raw materials. What if there was no more oil for heating homes or trees for making paper? Discuss which of these raw materials are considered renewable and non-renewable resources. Emphasize that in some cases (e.g., oil) it took millions of years to make the material and it cannot be quickly replaced.

5. Have each child try to think of another way to make the trash item they represent without making a new one out of raw materials. For example, they could take the container back to the store for refills, or take newspapers to be recycled. How could a bottle be made without using any new sand? Is there a connection between our shrinking supply of natural resources and the growing amount of waste?

EXTENSIONS

1. Have the children draw out the factory process, starting with the raw material and following what it is made into and what that is used for (e.g., sand--glass--bottle--holds milk). This could also be taken another step by completing what happens to the container after it has been used.

2. Make a bulletin board listing the raw materials used to produce common products. Have the children cut out pictures of objects made from these to add to their trash dictionaries.

3. Take the factory exercise a step further by having the children take back the item they represent to the factory to be made into a different product. Have students suggest how items might be re-used (e.g., newspaper used to manufacture cereal boxes).

5. Conduct a survey of items around the classroom and what kinds of raw materials were used to manufacture them. Which resource category and material type was the highest?

6. Start a game of Twenty Questions based on raw materials and how they are used. Put trash objects or cards with names of trash items into a bag. Let one student see a sample item. The class tries to guess what the object is by asking questions such as: Do I come from the earth? Am I made from a renewable or non-renewable resource? Am I a container? Am I recyclable?

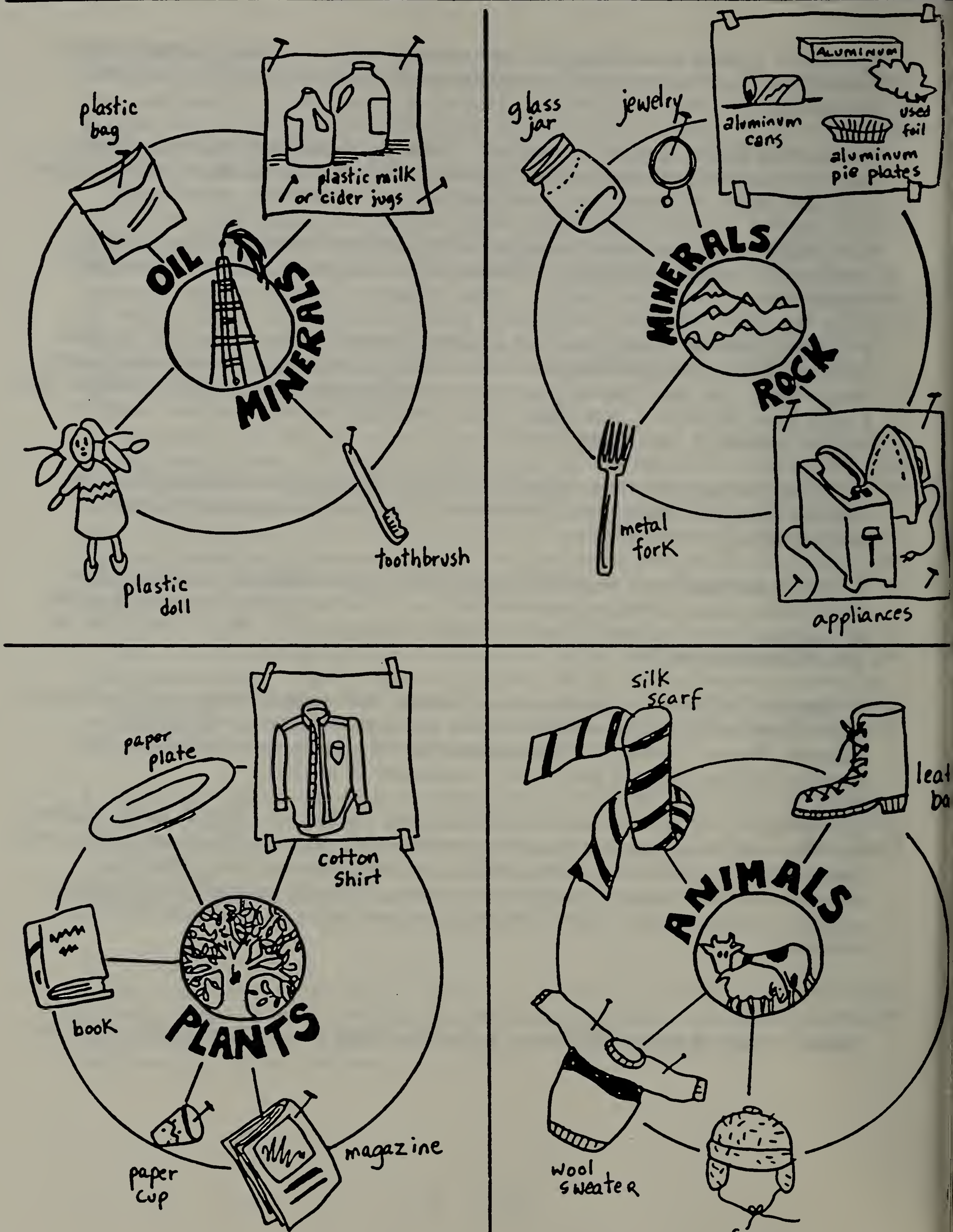
7. Make a Natural Resources Bulletin Board showing the four resource groups (see attached example). Have the children cut out pictures from magazines of products made from each resource type.

8. Assign each student a materials category (e.g., paper, metal, etc.) and have them write a short essay addressing questions such as: How has (paper) contributed to the development of our culture? How are (paper) products used? What is the effect on our natural resources?

9. Increase the level of detail for older children. For example, assign each the name of a specific mineral (bauxite, cassiterite, etc.), rather than the broad category of Minerals/Rocks. Have the students research where specific natural resources are plentiful and how they are used in the manufacture of products.

10. Distribute the attached worksheet, "What Are My Roots?" Explain to the students that often just looking at an item will not reveal much about the raw materials that were used to make it. For example, the soda can is made from aluminum which was manufactured from bauxite mined from the earth. Have the students work in teams to complete the worksheet or have them make posters tracing an item back to its raw materials.

Sources: Adapted from AVR *Teacher's Resource Guide*; *Oscar's Options*; Kristen Walser



Source: Reprinted with permission from AVR *Teacher's Resource Guide*

WHAT ARE MY ROOTS?

Try to trace each of the steps which changed these items from raw materials into the product we use. For example, the milk you had with lunch came from cows, who ate grass and other grains, which grew from the earth.

MILK ←------ COW ←------ GRASS / GRAINS ←------ EARTH

PLASTIC MILK CARTON

WOODEN TABLE

NEWSPAPER

GLASS BOTTLE

WOOL SWEATER

STEEL SHOVEL

STYROFOAM CUP

EGGS

LEATHER PURSE

COTTON THREAD

Source: Reprinted with permission from *Oscar's Options*

CREATING CRAYONS

THEME:	It takes raw materials, energy, time, and money to manufacture products
GOAL:	Student will examine how raw materials such as glass, metal, and plastic are transformed, often by heat, into other products
METHOD:	Making crayons
SUBJECTS:	Language Arts, Science
SKILLS:	Comparing, interpreting, observing
MATERIALS:	Old crayons with the paper removed and broken into little pieces; oven; little aluminum pans; aluminum foil; timer
TIME:	40 minutes

GETTING STARTED

Ask students if they know how forks are made?

PROCEDURE

1. Tell the students that they're going to be making crayons in much the same way that manufacturers produce forks, bottles, toys, or anything made out of metal, glass, or plastic. Explain that manufacturers start with a raw material, mix it with other raw materials, heat it, shape it, and then cool it.

2. Point out that the raw material used to make crayons is wax, which has been mixed with coloring. Collect old and broken crayons, remove the paper, and distribute the pieces to the children.

3. Have the students place broken crayon pieces in a little pie plate. They can also create their own molds by wrapping foil around a small object like a juice can and then carefully removing the object. Fill the mold with some of the old crayon pieces.

4. Place pie plates or molds in a larger pan and "cook" for about 10 minutes at 350° F. If possible, show the students the crayons while they are still liquid. After cooling, remove melted crayon mixture from the plate or mold. What happened to the crayons? What is the new product? What are the differences and similarities between the old and new products? Have the students write and draw about the process.

5. Show the students pictures of metal forges, clay kilns, and glassblowing or plastics factories. Explain that all of these processes use heat to transform raw materials into products that we commonly see and use. This comes from burning natural resources like gas, wood, oil or coal.

Source: Kristen Walser

RUNNING OUT OF RESOURCES?

THEME:	Some of our natural resources are renewable; others are not and once they are depleted cannot be replaced
GOAL:	Students will distinguish between items made from renewable and non-renewable resources
METHOD:	Completing worksheet and discussion
SUBJECTS:	Science, Social Studies
SKILLS:	Analyzing, evaluating, identifying
MATERIALS:	"Running Out of Resources" worksheet
TIME:	45 minutes

GETTING STARTED

What are natural resources? Will there always be enough? Which resources can be replaced? Which cannot?

PROCEDURE

1. Discuss the concepts of renewable vs. non-renewable resources, providing students with examples of each.

2. Have the class complete the worksheet "Running Out of Resources" and discuss the following:
   a) Which items on the worksheet do you use? Are they made from renewable or non-renewable resources?
   b) List some other items that you have and use. What natural resources are they made from?
   c) What might you do to conserve both renewable and non-renewable resources? What choices can you make about the items that you buy?

EXTENSIONS

1. Have students survey different items in the classroom and identify what natural resources were used to make them. Are they renewable or non-renewable? Are more items made from renewable or non-renewable resources? Can you think of an object made from a non-renewable resource that could be replaced by one made from a renewable resource?

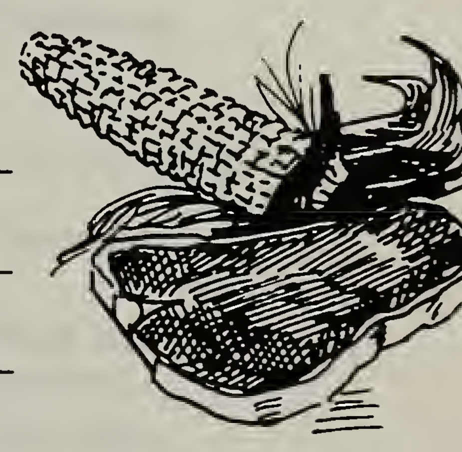
Sources: Adapted from *Garbage Reincarnation*; *Oscar's Options*

RUNNING OUT OF RESOURCES?

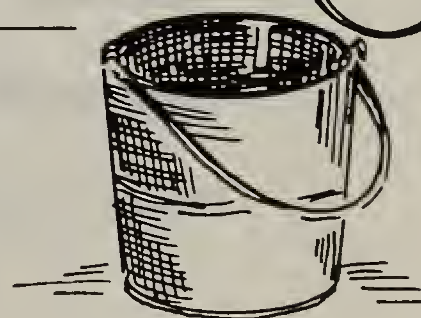
Some resources come from plants and animals which grow and reproduce. These can slowly be replaced if we use these resources wisely and plan ahead for the future. If we cut down a tree to make lumber, paper, or cardboard, we can plant a new tree. Since more trees can be grown, trees are called a renewable resource. Crops, animals and other things which can be replaced are renewable.

But there are some resources which cannot be replaced. The earth has only a limited amount of them and once they are gone there will be no more. These resources are non-renewable. We can't grow or make new copper or other precious metals. And when the last oil well runs dry, there will be no more oil for heat, for cars or for use in the many plastic products which are now part of our lives. In addition to minerals and fossil fuels, water and air are also non-renewable.

Directions: Identify the resource which is used to make each of the items listed below. For example, cardboard boxes are made from trees. In addition, think about whether that resource can grow or be replaced so that we will have more. Mark an **"R"** next to those items that come from a renewable resource, such as cardboard boxes. Place an **"NR"** next to those items which are made from sources that cannot be replaced. They are non-renewable.



cardboard box	________	aluminum pan	________
steel bucket	________	drinking glass	________
copper pipe	________	steak	________
book	________	corn on the cob	________
leather jacket	________	wool sweater	________
wooden desk	________	tire	________
cotton shirt	________	diamond ring	________
polyester shirt	________	plastic wastebasket	________



Source: Reprinted with permission from *Oscar's Options*

RUNNING OUT OF RESOURCES?
Teacher's Page

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cardboard box	**Tree**-R	aluminum pan	**Bauxite**-NR
steel bucket	**Iron**-NR	drinking glass	**Sand/Silica**-NR
copper pipe	**Copper**-NR	steak	**Animal**-R
book	**Tree**-R	corn on the cob	**Plant**-R
leather jacket	**Animal**-R	wool sweater	**Sheep**-R
wooden desk	**Tree**-R	tire	**Rubber Tree**-R
cotton shirt	**Plant**-R	diamond ring	**Diamond, Gold**-NR
polyester shirt	**Oil**-NR	plastic wastebasket	**Oil**-NR

Source: Reprinted with permission from *Oscar's Options*

TAKING CARE OF OUR LAND

THEME:	Our attitudes toward the natural environment affect how we use or misuse it
GOAL:	Students will develop an appreciation of the Native American philosophy, characterized by a respect for, and a belief in the interconnectedness of the earth
METHOD:	Reading and discussion
SUBJECTS:	Art, Language Arts, Social Studies
SKILLS:	Comparing, evaluating, inferring
MATERIALS:	"Selling the Land" essay
TIME:	One hour

BACKGROUND

Born in the vicinity of the city that now bears his name, Chief Seattle was the leader of the Dwamish and Suquamish Native American tribes. When the first white settlers came into the region, he greeted and befriended them. On January 22, 1855, Chief Seattle signed the Treaty of Point Ellington, thereby giving the land over to the settlers. His famous speech captures both the philosophy of Native Americans toward the land and his hope that its new stewards would treat it with reverence and respect.

GETTING STARTED

Do you ever think about your relationship with the natural world around you? Do you consider yourself superior to other living things? Why?

PROCEDURE

1. Read aloud the speech by Chief Seattle and discuss the following questions:

   a) How did Native Americans feel about the earth?
   b) Why does Chief Seattle feel that the land can never really be sold? Do you agree?
   c) What does he mean when he calls the murmuring water the voice of his "father's father" or the river his "brother?" What does this say about his relationship to nature? What importance does he place on it? How is it different from the way most of us think?
   d) What do you think of the last line? If Chief Seattle were alive today what would he think of the condition of the earth?

2. Have the children write or draw a short story illustrating how they would change the way we treat the earth. Ask what changes they would make to keep the water clean, the air pure and plants and animals safe?

EXTENSIONS

1. Tell the students they have just been notified that a place they find special is about to be significantly changed or taken away. Have each student write a speech which reveals their philosophy on the issues involved and expresses how they feel about the event. Organize a class forum and have each student present their talk, followed by a group discussion on the issues raised.

SELLING THE LAND

How can you buy or sell the sky? The land? The idea is strange to us. If we do not own the freshness of the air and the sparkle of the water, how can you buy them?

Every part of this earth is sacred to my people. Every shining pine needle, every sandy shore, every mist in the dark woods, every humming insect. All are holy in the memory and experience of my people.

We know the sap which courses through the trees as we know the blood that courses through our veins. We are part of the earth and it is part of us. The perfumed flowers are our sisters. The bear, the deer, the great eagle, these are our brothers. The rocky crests, the juices in the meadow, the body heat of the pony, and man, all belong to the same family.

The shining water that moves in the streams and rivers is not just water, but the blood of our ancestors. If we sell you our land, you must remember that it is sacred. Each ghostly reflection in the clear waters of the lakes tells of events and memories in the life of my people. The water's murmur is the voice of my father's father.

The rivers are our brothers. They quench our thirst. They carry our canoes and feed our children. So you must give to the rivers the kindness you would give any brother.

If we sell you our land, remember that the air is precious to us, that the air shares its spirit with all the life it supports. The wind that gave our grandfather his first breath also receives his last sigh. The wind also gives our children the spirit of life. So if we sell our land, you must keep it apart and sacred, as a place where man can go to taste the wind that is sweetened by the meadow flowers.

Will you teach your children what we have taught our children? That the earth is our mother? What befalls the earth befalls all the sons of the earth.

This we know: the earth does not belong to man, man belongs to the earth All things are connected like the blood that unites us all. Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web he does to himself.

One thing we know: our god is also your god. The earth is precious to him and to harm the earth is to heap contempt on its creator.

CHIEF SEATTLE

Source: *Sanctuary Magazine*, January 1990, pp.16

LEARNING ABOUT LITTER

THEME:	Litter is a serious problem which we can all help solve
GOAL:	Students will realize that their actions can help solve our solid waste dilemma
METHOD:	Litter walk and discussion
SUBJECTS:	Art, Social Studies
SKILLS:	Analyzing, examining, identifying
MATERIALS:	A rough scale map of the school grounds, divided into four or five areas; gloves; trash bags for collecting litter
TIME:	One hour

GETTING STARTED

Do you see litter on your way to school or on the school ground? What kind? Why do you think people litter?

PROCEDURE

1. Divide the children into four or five groups and distribute trash bags and gloves. Send each group to a designated area of the school yard, as shown on the map. Have students collect the litter in their area (excluding broken glass or other dangerous items).

2. Have each group sort through their bag and identify the types of litter they collected and the number of pieces in each category.

3. Discuss the following questions after each group has recorded their data.
   a) What kinds of litter did you find in your area? How much was there? Did you expect to find more? less?
   b) Where do you think it came from?
   c) Did some areas have more litter than others? Why?
   d) Were different kinds of litter found in different areas?
   e) What are some of the negative impacts of littering? (e.g., it's ugly, pollutes the earth, may be dangerous, etc.)

4. As a class, brainstorm ways to reduce litter in and around your school. Start a campaign to educate your school about litter. Have students design anti-litter posters, write and perform skits for other students, or campaign for more trash cans at school.

EXTENSIONS

1. Have students read (or read aloud) *The Wartville Wizard* by Don Madden, the story of a man given the power to make litter fly back onto the person who threw it away.

Source: Kristen Walser

TONS OF TRASH

THEME:	Every person in Massachusetts generates trash and contributes to the solid waste stream
GOAL:	Students will recognize that we all contribute to solid waste disposal problems and visualize how much waste is produced by each person in Massachusetts
SUBJECTS:	Math, Science, Social Studies
SKILLS:	Calculating, inferring, measuring, predicting
MATERIALS:	A seven pound bag of clean garbage (items that represent ordinary household trash); "How Much Trash Do You Figure?" worksheet
TIME:	One to two class periods

BACKGROUND

Each day, Massachusetts citizens fill trash bags or cans with food scraps, bottles, paper, junk mail, disposable diapers, plastic milk jugs, and empty food containers. We pile worn out tires on the curb next to stacks of newspapers, and we tote broken furniture out of our homes to the transfer station. It's trash, and since we don't need it or use it anymore, we throw it away.

In 1989, Massachusetts generated over ten million tons of solid waste. More than 6.6 million tons of this waste was from households, stores, schools, restaurants, and offices. This means that each person was responsible for about one ton of discarded waste in 1989, or about seven pounds per person per day. The sheer amount of waste generated has increased dramatically due to technological advances, the production of less durable products, and an increase in disposable packaging. In Massachusetts, two million tons of packaging alone are discarded each year. The magnitude and increased complexity of our solid waste stream has had serious impacts on our waste disposal methods, costs, and technologies.

GETTING STARTED

Show the students the bag of trash and ask them how long they think it would take to produce that amount of garbage.

PROCEDURE

1. Lay an old sheet or cloth on the floor and empty the bag of trash onto it. Discuss what kinds of things are in the pile. What are some qualities that make us consider an item to be trash? Does this pile of garbage represents a lot of trash? Tell the class that the seven pounds of garbage on the floor is equal to the amount of waste that is thrown out each day by the average person in Massachusetts. Ask the students how they feel

about the fact that they are responsible for generating seven pounds of trash per day or almost one ton of garbage each year? Will this number ever change? How? Why? (Possibilities include: changes in population, lifestyle, environmental ethics, and legislation, etc.)

2. Have the students complete the worksheet "How Much Trash Do You Figure?" and discuss the following questions: Where does all the garbage go? What would we do with our garbage if there were no transfer stations, landfills, or roadside pick-up? How might this affect the amount of trash you and your family produce? Do you think a family's income has any impact on the amount of waste it produces? What could you do to reduce the amount of garbage you produce?

EXTENSIONS

1. Have the students look through back issues of local or regional newspapers for articles on how the growing waste stream is affecting communities. The same thing can be done using magazines and newspapers that cover broader geographical areas. Have the class compare these findings to those in your region. Students could write a newspaper or magazine article summarizing the most common and/or most serious problems that they discovered. What are the future implications of these problems?

Source: Adapted from Wisconsin *Recycling Study Guide*

HOW MUCH TRASH DO YOU FIGURE?

❶ If you generate seven pounds of trash each day, how many pounds do you produce every:

week _____ month _____ year _____

❷ Convert these numbers from pounds to tons. How many tons of trash do you produce every:

week _____ month _____ year _____

❸ To visualize how much a ton weighs, add together the weights of the students in the class until you reach a ton.

a. How many kids does it take to make a ton? _______________

b. What is the average weight of a student in your class? ________

c. How many "students-worth" of trash do you make every:

week _____ month _____ year _____

❹ How many people are there in your family?
If seven pounds of trash is generated each day for every person, how many pounds and tons of trash does your family produce every:

Pounds– week _____ month _____ year _____

Tons– week _____ month _____ year _____

❺ How many people are there in Massachusetts? ______________________
How many pounds and tons of trash are generated in the Commonwealth each:

Pounds– day _____ week _____ month _____ year _____

Tons– day _____ week _____ month _____ year _____

❻ If every person in Massachusetts threw away one less pound of trash per day, how much would our state's solid waste stream be reduced?

____

Source: *Wisconsin Recycling Study Guide*

THROWING IT ALL AWAY

THEME:	Our consumer-oriented society produces a lot of waste
GOAL:	Students will understand the sources, content, and magnitude of the solid waste problem
METHOD:	Questionnaire and discussion
SUBJECTS:	Language Arts, Math, Social Studies
SKILLS:	Inferring, interpreting, predicting, problem solving,
MATERIALS:	"Throwing It All Away" questionnaire
TIME:	One class period

GETTING STARTED

Ask the students what they know about the solid waste we produce. Does it creates any problems?

PROCEDURE

1. As an introduction to the problems associated with solid waste, distribute the "Throwing It All Away" questionnaire and allow time for completion. Students could also bring the questionnaire home and complete it with their families.

2. Discuss questionnaire and encourage students to share their reactions to the answers. (NOTE: Solid Waste Fact Sheet at the end of the Activity provides additional information for each of the questions.) Discuss the implications and problems associated with each of the issues, as well as possible solutions to some of these problems. What can we do to address these issues in our personal lives? as community members? as members of government, business, or industry?

EXTENSIONS

1. Have the students create their own questionnaire. Some of the same questions may be used but the survey should also include original questions which explore local solid waste issues. Have the students work together to come up with one set of questions for the class. Questionnaires can be filled out by other classes, the entire school, and/or by people in the community. Students can then tabulate the results to determine what people do and do not know about solid waste issues. (Various groups may respond differently so students may want to tabulate surveys separately.)

2. As a follow up to the survey, have students create educational fact sheets which discuss the answers to the questions. They should focus on providing information on those issues with which people were the least familiar. These information sheets can be computer generated or made into posters and illustrated. Once completed, students should distribute them and/or create a display in a public area of the school or town, such as the library or town hall. Again, depending on the results of the survey, different fact sheets may be necessary for different groups, especially if the survey population includes people of varying ages.

Source: Reprinted with permission from AVR *Teacher's Resource Guide*

THROWING IT ALL AWAY QUESTIONNAIRE

Check the answers that you think are correct

1. How many pounds of trash does the average American family of four produce each week?	20	150
	500	1000
2. In the past fifty years, the amount of waste discarded per person in the U.S. has:	stayed the same	decreased
	doubled	increased ten times
3. How many million pounds of edible food do Americans throw away each day?	1	100
	400	900
4. How many cars do we send to the junkyard each day?	250	1000
	10,000	20,000
5. How many TV's are thrown out each year?	100,000	5.2 million
	1 million	7.6 million
6. What percentage of packaging (boxes, bags and wrappers) is thrown out as soon as we open a product?	90%	75%
	50%	10%
7. How much paper do Americans use each year?	1 million tons	1 million pounds
	5 million tons	50 million tons
8. How many tons of municipal solid waste (from households, schools, stores, restaurants, and offices) did residents of Massachusetts produce in 1989?	500,000	1.5 million
	4.5 million	7 million

Source: *AVR Teacher's Resource Guide*

SOLID WASTE FACTS

Answers to the "Throwing It All Away" Questionnaire

1. The average American family of four creates about 150 pounds of trash each week. Multiplied by 52 weeks, this equals 7,800 pounds each year. To help envision this amount of waste, picture 9 horses (950 lbs each), 4-1/2 cows (1,800 lbs. each), 5 pilot whales (1,500 lbs. each), or a World War II German fighter plane (7,700 lbs.) In Massachusetts, the average family of four produces 196 lbs of trash per week.

2. In the past 50 years, the amount of waste discarded per person in the U.S. has doubled. Increased packaging, a rise in the use of disposable products, development in industry and production technology, an increase in personal wealth and purchasing power, and the switch to "planned obsolescence" as a design strategy are all contributing factors to the increase in personal consumption and disposal.

3. Each day, Americans throw away 400 million pounds of edible food. In addition to our food waste, farmers in the U.S. produce a surplus of food that is not used and is often discarded. In contrast to the situation in the U.S., millions of people are underfed and undernourished throughout the world. The United Nations estimates that 460 million people do not receive an adequate amount of the right kinds of food. The diet of these people is frequently lacking in:

* calories: Fewer than 2,200 calories per day is the norm in China, India, and much of Africa. The average U.S. citizen consumes more than 3,300 calories per person per day.
* protein: Less than 60 grams-per-day is the average for the countries mentioned above, compared to a 90 gram-per-day average in the U.S.
* needed micronutrients: Very often a lack of variety in diet causes deficiencies in important nutrients, vitamins, and minerals.

Even people who get enough calories per day could be suffering from malnutrition due to these types of deficiencies. This is a common occurrence right here in the U.S. In many cases malnutrition exists not because we do not produce enough food, but rather because of an unequal distribution of what is grown. The most affluent one-third of the world's population eats well over one-half the food produced.

4. We send 20,000 cars to the junkyard each day or 7 million cars (and 200 million tires) per year. Placed end to end, the cars discarded each year would reach two-thirds of the distance around the earth at the equator.

5. Some 7.6 million TVs are thrown away each year. Television sets last, on average, ten to fifteen years. The number of appliances and audio-visual equipment thrown out within only a few years reflects a fast turnover in technology, the consumer's desire for state-of-the-art equipment and new fashion, a planned obsolescence design strategy by producers, and the fact that it is often less expensive to buy something new than to repair something old.

6. Approximately 90 percent of packaging is thrown out right away. Packaging is increasingly made of materials are made of plastic, which is noted for its non-biodegradability and long life.

7. Americans use 50 million tons of paper each year. It takes 17 trees to produce one ton of paper, and 10,000 trees to print one edition of the Sunday *New York Times*. Newspapers are usually discarded within 24 hours of being purchased, and only one-fourth of the paper produced in the U.S. is recycled.

8. Massachusetts residents produced over 6.6 million tons of municipal solid waste in 1989. An additional 3.4 million tons of waste, including industrial wastes, sludge from waste water and industrial processes, demolition and construction debris, used appliances or white goods, tires, waste oil and asbestos were generated that same year. These wastes require special handling and processing before and during disposal.

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PRODUCTION BYPRODUCTS--GETTING TO THE SOURCE

THEME:	Everything we do, as well as certain products we use, generates some type of waste
GOAL:	Students will learn that every process creates byproducts or waste
METHOD:	Research and interviews
SUBJECTS:	Language Arts, Science, Social Studies
SKILLS:	Interviewing, problem solving, researching
MATERIALS:	None
TIME:	Several weeks

BACKGROUND

When we look in our trash it is fairly easy to determine how these items became trash. Our garbage generally contains materials we no longer want, those products we've used up, and the byproducts of things we do or make. Similarly, industry and business produce waste as they convert raw materials into products we can utilize. The nature and amount of waste generated depends on the type of products being manufactured and the size of the company. Safe disposal of this waste is an issue which industries and businesses must continuously address.

GETTING STARTED

Ask the students to consider the types and amount of waste generated in the production and processing of items that are part of our daily lives.

PROCEDURE

1. Have the class come up with a list of items produced in Massachusetts and another list of industries and businesses in the state. Some examples include cranberries, fisheries and fish processing, furniture, plastics, and computer and electronics equipment. Have the students speculate on the kinds of waste each one generates. How do manufacturers dispose of these various wastes? Are some wastes more difficult to get rid of than others? Which wastes require the most costly disposal processes?

2. Have each student research one of Massachusetts' products or industries. Students should contact the manufacturers to find out: What is involved in the production process? What kind, and how much, waste is generated? What does the company do with the waste? What are their waste disposal costs? Are these costs increasing, decreasing or staying the same? What affects this price? Are they planning to make any changes in their waste disposal methods? Do they currently use any recycled products? If not, have they ever considered it?

3. Students should write about what they've discovered and suggest changes that could benefit the manufacturer, consumers, and the environment. (Waste reduction and recycling programs are two possible options.) Students could send these suggestions to the manufacturer or try to meet with them in person, or write an article for the local paper.

EXTENSIONS

1. Have the students draw diagrams to illustrate the manufacturing process. These should include raw materials used, conversion or production processes involved, byproducts generated and where they go, and the final manufactured product. This can be taken one step further to include the market and the consumer.

2. Have the class brainstorm possible uses and potential products that could be made out of production wastes (e.g., fertilizer from fish remains).

Source: Adapted from AVR *Teacher's Resource Guide*

HOME SAFE HOME

THEME:	Many household substances can be dangerous and should be used with great caution
GOAL:	Students will identify which household products are toxic and predict the results of improper use and storage
METHOD:	Reading and discussion
SUBJECTS:	Health, Language Arts, Science, Social Studies
SKILLS:	Inferring, predicting, problem solving
MATERIALS:	"Home Safe Home" handout; "Unsafe Situations" worksheet; drawing materials
TIME:	One hour

GETTING STARTED

Distribute the "Home Safe Home" handout and discuss it with the students. Do they have any of these kinds of products in their homes? Do they ever use them? If so, do they use any precautions (e.g., rubber gloves, face mask)? Where are these products kept? Did they ever consider how dangerous these products might be?

PROCEDURE

1. Distribute the "Unsafe Situations" worksheet and use it in one of the following ways. (Note the accompanying Teacher's Page).

   a. Have the students complete their predictions in writing. Discuss both their predictions and methods for rectifying the unsafe situations;

   b. Read aloud each of the Unsafe Situations scenarios and have the students brainstorm both problems and solutions; or

   c. Have teams of students act out one of the scenarios and encourage classmates to suggest ways in which the situation may have been avoided.

2. After the students have completed the worksheet, discuss the results. Help them identify ways of minimizing the chances of accidental poisoning (e.g., storing materials in original containers, keeping toxic materials on high shelves or in locked cabinets, using child proof caps, etc.). Discuss the best method for dealing with accidents involving hazardous household materials. If there is a local poison control center, inform students and discuss its purpose.

3. Distribute drawing materials. Have the students make a diagram of their home and label, by location, twenty items commonly found there which they believe may be toxic. Examples might include: nail polish remover, furniture stripper, flea powder, spot remover, kerosene, toilet bowl cleaners, detergent, weed killers, motor oil, antifreeze, brake fluid, paint, deodorizers, oven cleaners, moth balls, bleach, scouring powder, bug spray, and charcoal lighter fluid.

EXTENSIONS

1. After the students have drawn and labeled their homes, have them trace the routes through which hazardous household substances could get into the environment. Possibilities include evaporation, leaching, seepage, runoff, and dumping. Point out that hazardous household materials are not only dangerous to humans, but can also affect other living creatures and the environment.

2. Have the students survey their homes to see how many toxic items are actually used by their families.

3. Point out to students that industry and business also use toxic materials. Have students research a well-known toxic catastrophe such as Love Canal or the Exxon Valdez oil spill, or, more locally, the contamination of wells in Hatfield or Woburn. How and why did these incidents occur? What were the acute effects? What were the chronic effects? Could these incidents have been prevented? How? Have students write reports summarizing their findings and present the information to the class.

Source: Adapted from *Oscar's Options*

HOME SAFE HOME

You may think of your home as a safe place in which to play and live. But within your home there are many unsafe things. Toxic chemicals can be found in just about every room. Toxic means poisonous. Using such a substance carelessly may result in injury, illness, or death.

Where are these poisons and what are they doing in your house? They are found in cleaning compounds, pet products, and home maintenance supplies. We use them to make our home cleaner and our lives easier.

But they can be harmful to our health. Eating or drinking a toxic substance can be fatal. Even proper use of toxins can lead to real problems. Headaches, lightheadedness, and nausea are acute symptoms. They are immediate reactions to inhaling a toxic substance or getting too much on your skin. Chronic reactions take a long time to appear. Cancer and damage to the liver, kidneys, or the central nervous system can be the result of exposure to toxic substances.

Source: Reprinted from *Oscar's Options*

UNSAFE SITUATIONS

PRODUCT: Drain Cleaner
SITUATION: When the doorbell rang, the bottle was left on the bathroom floor. A baby was playing nearby.
PREDICTION:

PRODUCT: Lemon Furniture Oil
SITUATION: When polishing some furniture, the cap was lost. Polish was then placed in a glass near the sink.
PREDICTION:

PRODUCT: Pills
SITUATION: Medicine was left on nightstand to help remind the patient to take it.
PREDICTION:

PRODUCT: Antifreeze
SITUATION: After changing the antifreeze in a car, someone threw it into a ditch in front of the house.
PREDICTION:

PRODUCT: Aerosol Air Fresheners/Deodorizers
SITUATION: A cooking smell was unpleasant so air freshener was sprayed in the kitchen. The can was left sitting on the stove.
PREDICTION:

PRODUCT: Chlorine Bleach/ Ammonia

SITUATION: A bathroom tile wouldn't come clean using a bleach cleanser, so the person cleaning mixed some ammonia with the cleanser to make it stronger.

PREDICTION:

PRODUCT: Furniture Stripper

SITUATION: Your neighbor decided to strip the paint off of an old chair. He is working in his workshop and turns on the fan.

PREDICTION:

PRODUCT: Hair Spray

SITUATION: Your sister sprayed her hair to keep the style in place. She left the can on the radiator in the bathroom.

PREDICTION:

PRODUCT: Pesticides

SITUATION: To kill ants in the kitchen, an insect spray was applied to the floor. People in the home are often barefoot.

PREDICTION:

PRODUCT: Oven Cleaner

SITUATION: Although the product called for the use of rubber gloves, the housekeeper felt they were too clumsy and used the product without them.

PREDICTION:

Source: Reprinted with permission from *Oscar's Options*

Teacher's Page

UNSAFE SITUATIONS

PRODUCT: Drain Cleaner
SITUATION: When the doorbell rang, the bottle was left on the bathroom floor. A baby was playing nearby.
PREDICTION: Child could drink it; product is corrosive to skin and eyes.

PRODUCT: Lemon Furniture Oil
SITUATION: When polishing some furniture, the cap was lost. Polish was then placed in a glass near the sink.
PREDICTION: Someone might drink it, thinking it was safe; color and scent make it attractive.

PRODUCT: Pills
SITUATION: Medicine was left on nightstand to help remind the patient to take it.
PREDICTION: Children might assume it is candy and eat it.

PRODUCT: Antifreeze
SITUATION: After changing the antifreeze in a car, someone threw it into a ditch in front of the house.
PREDICTION: Pets have died from drinking puddles of antifreeze; they are attracted by its sweet taste; environmentally damaging.

PRODUCT: Aerosol Air Fresheners/Deodorizers
SITUATION: A cooking smell was unpleasant so air freshener was sprayed in the kitchen. The can was left sitting on the stove.
PREDICTION: Fumes may make residents sick, or adhere to food; can could explode due to heat.

PRODUCT: Chlorine Bleach/ Ammonia

SITUATION: A bathroom tile wouldn't come clean using a bleach cleanser, so the person cleaning mixed some ammonia with the cleanser to make it stronger.

PREDICTION: **Mixing chlorine bleach and ammonia releases a toxic gas; the fumes can result in eye, throat, nose irritations and breathing difficulty; products should never be mixed.**

PRODUCT: Furniture Stripper

SITUATION: Your neighbor decided to strip the paint off of an old chair. He is working in his workshop and turns on the fan.

PREDICTION: **Using a fan in closed quarters will only recirculate the bad air; such products need extreme caution and plenty of fresh air.**

PRODUCT: Hair Spray

SITUATION: Your sister sprayed her hair to keep the style in place. She left the can on the radiator in the bathroom.

PREDICTION: **Fumes from chemical sprays can irritate and damage skin, eyes, and lungs; they can also cause internal harm by entering bloodstream through the lungs; containers can explode from the heat.**

PRODUCT: Pesticides

SITUATION: To kill ants in the kitchen, an insect spray was applied to the floor. People in the home are often barefoot.

PREDICTION: **Chemicals can penetrate socks and be absorbed through the skin; health effects of pesticides, especially long-term effects, are not fully known.**

PRODUCT: Oven Cleaner

SITUATION: Although the product called for the use of rubber gloves, the housekeeper felt they were too clumsy and used the product without them.

PREDICTION: **The chemicals could cause the skin to burn or develop a rash; skin and eye contact should be avoided.**

Source: Reprinted with permission from *Oscar's Options*

EVERYWHERE IS SOMEWHERE

THEME:	Toxic wastes have far-reaching effects on the environment
GOAL:	Students will analyze our waste disposal practices and the serious environmental consequences that can result
METHOD:	Reading and analyzing
SUBJECTS:	Science, English, Environmental Studies
SKILLS:	Analyzing, value judgments
MATERIALS:	"Everywhere is Somewhere" poem
TIME:	One class period

GETTING STARTED

What are some toxic materials that you use? After you use these materials, where do they go? How does this effect the environment?

PROCEDURE

1. Read the poem and discuss the following:

   a. When people discard hazardous materials, do you think they usually consider the environmental impacts?
   b. In light of the poem "Everywhere is Somewhere," what problems do you foresee in the future, especially if we don't change our toxic waste disposal methods?
   c. How can we educate the public about the implications of our throwaway habits? The poem was one effective way: Can you think of others?

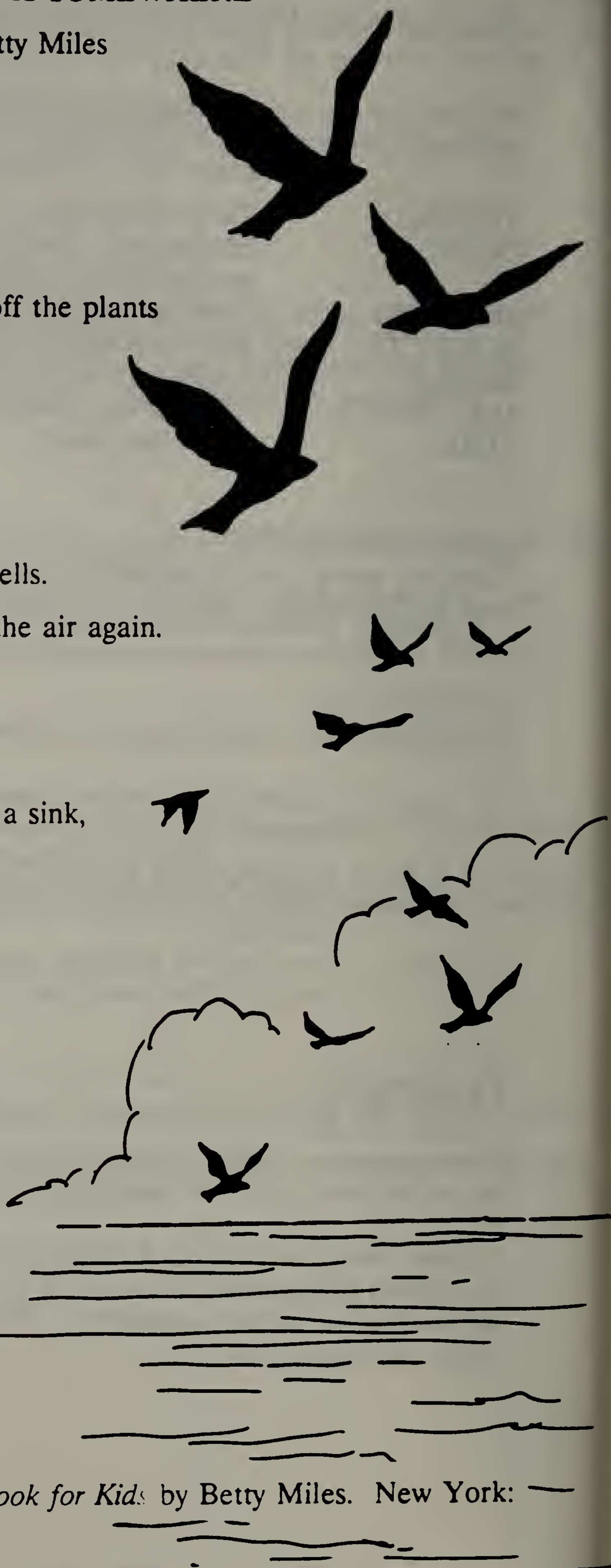
EXTENSIONS

1. Have the students read Rachel Carson's *Silent Spring* or Aldo Leopold's *A Sand County Almanac*. What message(s) are these authors trying to get across? In what ways do our actions affect the world around us?

2. Have the students write a poem similar to "Everywhere is Somewhere" which discusses the effects of hazardous waste on a living creature(s). The poems should address: Where did the poison come from? How did it affect different organisms? How did it affect the ecosystem?

EVERYWHERE IS SOMEWHERE

by Betty Miles



When people spray poisons into the air
to kill plant eating insects,
the insects may die
but the poison does not go away.
It stays, unseen, in the air.
And it falls, perhaps years later,
on other plants and on the land.
When the rains come, some poisons wash off the plants
and run off the land
into ponds and lakes and rivers.
The poison is always somewhere.
It gets into water plants
and small water animals
and into the fish that eat them.
Birds of the air catch the poisoned fish,
or eat the poisoned insects,
and poison gets into the birds.
The poisoned bird lays eggs with soft eggshells.
No baby birds will come out of these eggs.
Some kinds of birds will never fly through the air again.
They are gone forever,
because of poisons in the air.
In the air everywhere is somewhere.
Nowhere is away.

When you rinse garbage down the drain of a sink,
or flush trash down the toilet,
it does not go away;
it goes somewhere.
Sewage and waste go into big pipes.
The pipes go into the river.
The river runs into a bigger river.
The big river flows to the sea.

Far, far away
in the middle of the ocean,
garbage and trash float on the sea water.
Pollution does not float away;
it floats somewhere.
And it will stay there,
floating and sinking under the sun,
for years and years.

When you rinse something down the drain,
it does not go away--
it goes somewhere.
In the water, everywhere is somewhere.

Source: *Save the Earth! An Ecology Handbook for Kids* by Betty Miles. New York: Alfred Knopf, Inc., 1974.

STALKING HAZARDOUS WASTES: WHERE DO THEY GO?

THEME:	Improper disposal of hazardous wastes is harmful to the environment
GOAL:	Students with examine common disposal practices and gain an appreciation of better disposal options
METHOD:	Role-playing with discussion
SUBJECTS:	English, Theatre
SKILLS:	Analyzing, communicating, problem solving, value judgement
MATERIALS:	"Where Does It Go?" handout; "Where Should It Go?" handout; Problem-solving exercises: scenarios, cut into cards; Problem-solving exercises: decision sheet
TIME:	One to two hours

GETTING STARTED

Ask the students what happens to household hazardous wastes if they are poured down the sink? brought to the landfill? burned in an incinerator? How are these practices harmful to the environment?

PROCEDURE

1. Distribute informational sheets, "Where Does It Go?" and "Where Should It Go?" Discuss the information with the class. Have the students make a diagram of their homes indicating all avenues for disposal of household hazardous materials and where the material goes. This should trace, for example, the route of material poured down the kitchen sink, from septic tank to leach field or, when pumped, to a treatment facility, etc.

2. Tell students they are going to role play the decision-making process for dealing with some common household hazardous substances. Divide the class into three groups and assign each a different scenario. The three scenarios are:

SCENARIO #1: Hilda discovers a can of gasoline in her garage. What should she do with it? If she decides to dispose of it, what options does she have?

SCENARIO #2: A group of neighbors is setting up a community gardening project. They have purchased the plot of ground and are meeting now to make some decisions about policy. The first issue they decide is whether to use Slug Bait in their garden.

SCENARIO #3: Nine individuals who have operated independent cleaning services have decided to combine their talents to create the Zippy Cleaning Service. As a group they need to make some decisions about the products they will use and the policies they will follow.

3. Each student should get one card listing a possible reaction to the question raised in their scenario. They must represent that point of view in a group discussion on how the situation should be handled. Point out to the students that there is not necessarily one correct answer to these problems. These are current situations for which the state--and society at large--are trying to find a good solution.

4. Allow 30 minutes for discussion, at which time each group should make a recommendation concerning their particular dilemma. Have an assigned scribe keep track of the discussion (on the attached Decision Sheet) to tell the class what factors were considered prior to achieving a consensus.

EXTENSIONS

1. After completing one set of scenarios, allow the groups to discuss the other scenarios. Compare the final recommendations and the decisions made to reach those conclusions. How did they differ?

2. Have the students write an essay on how they would respond to one of the three scenarios.

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WHERE DOES IT GO?

When you wash your clothes in sudsy detergent, where does it go? When you clean your sink with cleanser, where does it go? When you pour a waste into the street drain, where does it go? It doesn't disappear; it all goes somewhere. It all helps or hurts someone or something.

All the drains in your house lead from the bathroom, kitchen, and laundry room down to one large drain. The watery wastes pass into a septic tank, if you live in the country. A septic tank is a large underground concrete container. Wastewater spends two or three days there. Solids settle to the bottom of the tank. Liquids are piped into a drainfield which allows them to seep slowly into the soil. This solid sludge must be pumped out approximately every five years. It is then taken to a sewage treatment plant.

If you do not have a septic tank, then your wastewater is piped from your house to the sewage treatment plant. Underground pipes mix the liquids from homes, stores, and factories. At the sewage plant, wastewater is treated with bacteria. This can remove only some of the harmful materials. Then the waste is diluted with water and discharged into nearby lakes or streams.

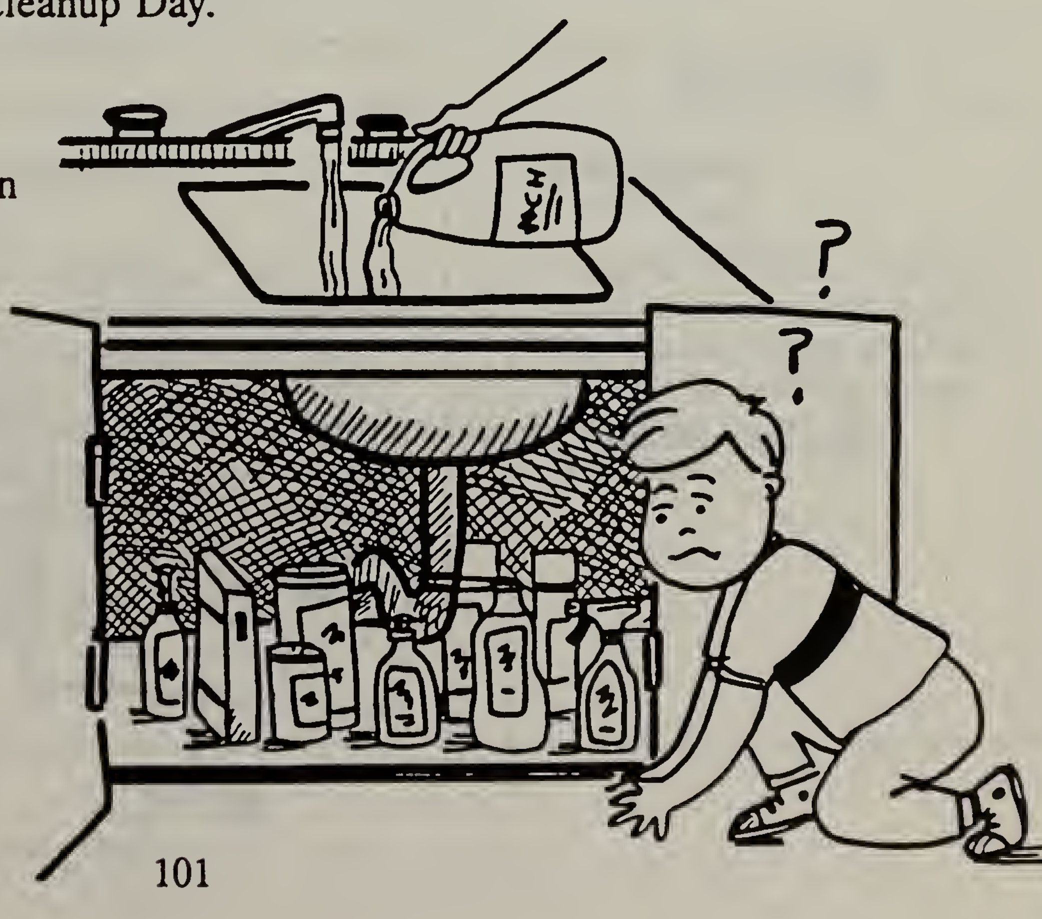
Pouring wastes into storm drains is illegal. That's because they lead directly to waterways. Many chemicals could harm the fish, or poison humans who eat the fish or drink the water.

Dumping wastes on the ground pollutes the soil. As the poison seeps into the soil, groundwater supplies may be ruined.

Burning toxic wastes is not a good idea, either. Harmful gases contaminate the air. Aerosol cans will explode.

There are only two good solutions to toxic wastes. Use as little as possible. Then dispose of any wastes at a Toxic Cleanup Day.

Source: Reprinted with permission from *Oscar's Options*



WHERE SHOULD IT GO?

DOWN THE DRAIN WITH LOTS OF WATER

powder cleaners
window cleaner
toilet cleaner
bleach

EVAPORATE SMALL AMOUNTS OUTSIDE AWAY FROM CHILDREN AND PETS. THROW RESIDUE IN GARBAGE CAN

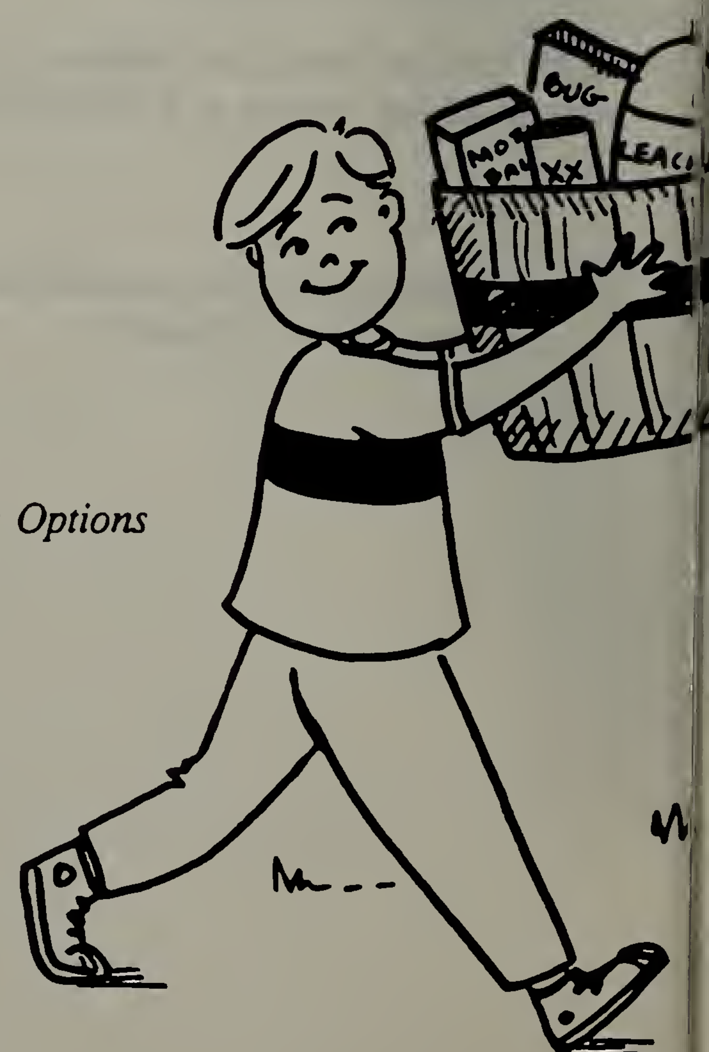
latex paint

TAKE TO A HOUSEHOLD HAZARDOUS WASTE COLLECTION SITE

pool cleaning agents
drain cleaner
silver polish
flea powder
kerosene
auto antifreeze
mothballs
spot removers
house insecticides
rat poison
paint stripper

RECYCLE

car batteries
motor oil



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PROBLEM SOLVING EXERCISES

Scenario #1: Hilda's Can of Gasoline

Scenario #1

You are Hilda's neighbor, Nancy Nextdoor. You point out that gasoline evaporates. Maybe Hilda should just evaporate the gasoline. But, you know that the fumes are dangerous--poisonous, in fact. There are small children in the neighborhood. You also wonder if evaporation might cause some air pollution.

Scenario #1

You are Lt. John Jones of the local fire department. It is very dangerous to store gasoline as it is a fire hazard.

Scenario #1

You are Hilda's brother-in-law, Fred. You tell Hilda that gasoline is an effective weed killer. Hilda has a large patch of blackberries in the corner of her lot. Maybe she should throw the gasoline on the ground around the berries.

Scenario #1

You are Joe Cleandrain from the sewage treatment plant. You tell Hilda that it is against regulations to pour gasoline down sink, sewer, or storm drains.

Scenario #1

You are Pat, Hilda's neighbor. You know that gasoline is a solvent. How could Hilda use a solvent? You suggest that Hilda check with a recycling center that takes solvents. But, the only one you know of is 25 miles away--clear over on the other side of county.

Scenario #1

You are Chris, Hilda's son's high school buddy. You say that your dad has always poured his excess gas down the storm drain in front of the house. It is such a small quantity that it can't possibly hurt anything.

Scenario #1

You are Peter Putrescible, a representative of the community landfill. You tell Hilda that the landfill will not accept flammable materials.

Scenario #1

You are Hilda. You discovered a can of gasoline in your garage while you were cleaning. You don't know exactly how long it has been there. Because you are worried that it may have water, oil, or rust in it, you have decided not to use it in your car.

Scenario #1

You are Hilda's son, Ralph. Another friend of yours says that his dad is glad when he has excess gasoline around. He uses it to start the barbeque.

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PROBLEM SOLVING EXERCISES

Scenario #2: The Community Garden

Scenario #2

You are Bob Tool. You own the Valley Hardware and Garden Store. You know that Metaldehyde is the active ingredient in slug baits. It was first discovered in 1936 and has been around for a long time.

Scenario #2

You are Sally Street. You have used salt on the slugs in your own garden. Last year you used saucers of beer to get rid of them. Although it worked pretty well, the saucers had to be changed often and sometimes it seemed like too much work.

Scenario #2

You are Sandy Beach. You read in a gardening magazine that kelp or seaweed laid around the edges of the garden would get rid of slugs. They crawl over the salty surface of the seaweed and the salt causes them to dry out and die.

Scenario #2

You are Polly Puregard. You checked with the local "Grow 'Em" Community Garden people. They don't allow any chemicals in their community gardens. If this project allows chemicals, you don't want to participate.

Scenario #2

You are Ned Punchly. You suggest that boards be laid around the individual beds. The slugs will crawl under them during the day and someone can then turn the boards over and collect or kill them. Or, maybe the group could elect a member to go out at night with a flashlight and collect them.

Scenario #2

You are Susan Feathers. You recommend that the group build two fences; one right around the garden plot and another 2 or 3 feet away from the first. The group could then put ducks and geese in this enclosed area. They would eat the slugs before they could get into the garden.

Scenario #2

You are Rita Byeby. You recommend planting sacrificial rows of bok choy, lettuce, cabbage, or other vegetables, all around the perimeter of the garden. These vegetables will keep the slugs busy and they will never get into the "real" garden.

Scenario #2

You are Dudley Doread. You read the label from a slug bait container and know that it is toxic to pets. Some pets have been poisoned by accidentally eating it in the garden. You also discovered that you are supposed to keep it away from the edible parts of the vegetables. What does this mean?

Scenario #2

You are John Goodgardner. You have tried over the years to garden with a minimum of chemical pesticides and fertilizers. But last year you lost most of your lettuce to the slugs and that was a real disappointment. You also want the project to work and want everyone to feel comfortable with the decisions that the group makes.

Source: Reprinted with permission from *Oscar's Options*

PROBLEM SOLVING EXERCISES

Scenario #3: The Zippy Cleaning Service

Scenario #3

You are Annie Aerosol and are very concerned about aerosol cleaners. You know they are popular but not very cost efficient. Small droplets can land on other objects besides those being cleaned and some propellants can damage the ozone layer around the earth. Disposal of aerosol cans also creates problems because they may explode if they get too warm.

Scenario #3

You are Priscilla Polish and have been looking into the amount of hydrocarbons, petroleum distillates, and napthas in polishes and cleaners. You have found that they can cause skin rashes, as well as eye, nose, throat, and lung irritation. They are also hazardous when ingested. Repeated exposure can result in liver and kidney damage.

Scenario #3

You are Granny Smith and have researched some alternatives to conventional cleaners. For example, several teaspoons of vinegar in water works well for cleaning glass and marble. Baking soda is recommended for items that are particularly greasy, such as coffee pots, chrome, and tile.

Scenario #3

You are Tom Smellnice and are concerned about disinfectants and deodorizers that end up down the drain or in the air after they are used. You realize that these products do not create a germ-free environment anyway. You also wonder about toilet bowl cleaners that are flushed into the sewer or septic tank. Does this create a problem?

Scenario #3

You are Carl Caustic and are concerned about alkalies found in dishwashing and laundry detergents, and oven and drain cleaners. Swallowing such products can result in severe stomach pains and burns in the mouth and throat. Inhalation can cause severe coughing and burns to the throat and lungs. Skin and eye contact can also cause burns and possible damage to the cornea.

Scenario #3

You are Bob Bleach and have researched alternatives to commercial disinfectants. You have found that 1/4 cup bleach in 1 quart of water works well for cleaning many surfaces including, counter tops, floors, toliet bowls, and bathtubs.

Scenario #3

You are Jack Cleanwater and are concerned about the phosphates in detergents, as well as the cleaning agent TSP. You heard that phosphates can threaten the health of lakes, rivers, and streams by encouraging algae growth.

Scenario #3

You are Cloris Toxgas and are concerned with the human health hazards of chlorine. It is the basic ingredient of some bleaches and drain cleaners, and can cause burns and surface damage to eyes. If mixed with an acid or ammonia, a highly toxic gas is produced. Inhalation is especially dangerous to those with lung problems and can result in death.

Scenario #3

You are Lisa Lemon and have researched some alternatives to commercial furniture polishes and recommend the following substitutes:

1 teaspoon lemon oil
1 pint mineral oil

or equal parts of:

turpentine, boiled linseed oil, and vinegar, plus a few drops of lemon oil for fragrance.

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PROBLEM SOLVING EXERCISES
Decision Sheet

Which Scenario? ____

Students in the group: ______________________________________

After each person in the group contributes information and the entire problem unfolds, what do you see as the ISSUES in this exercise? ______________________________

____

POSSIBLE SOLUTION:

What are some tradeoffs to this solution?	What environmental, or human health EFFECTS could result from this solution?
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

POSSIBLE SOLUTION:

What are some tradeoffs to this solution?	What environmental, or human health EFFECTS could result from this solution?
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

POSSIBLE SOLUTION:

What are some tradeoffs to this solution?

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POSSIBLE SOLUTION:

What are some tradeoffs to this solution?

What environmental, or human health EFFECTS could result from this solution?

FINAL DECISION: ______________________________

Was the entire group satisfied with the decision? If not, why? ______________________________

Note any COMMENTS and QUESTIONS that your group had during the decision-making process. Discuss these with the rest of the class. ______________________________

Source: Reprinted with permission from *Oscar's Options*

HOUSEHOLD HAZARDOUS WASTE AUDIT

THEME:	The average household contains many products that could be designated as hazardous materials
GOALS:	Students will identify hazardous household products, understand the health hazards associated with them, learn non-toxic alternatives to many commonly used household products, and become familiar with safe ways to recycle and dispose of household hazardous waste
METHOD:	Household hazardous waste audit and preparing advertisement
SUBJECTS:	English, Science, Theatre
SKILLS:	Analyzing, comparing, researching
MATERIALS:	Examples of toxic household products; Hazardous Waste Wheel (available from EHMI, 10 Newmarket Rd., Durham, NH 03824; (603) 868-1496); Household Hazardous Waste Brochure (available from the Department of Environmental Management, Office of Safe Waste Management, 100 Cambridge St., Boston, MA 02202; (617) 727-3260
TIME:	45 minutes, plus several hours for audit

BACKGROUND INFORMATION

A hazardous material is a poison, corrosive agent, flammable substance, explosive, radioactive chemical, or any other material which can endanger human health or well-being if handled improperly. Many household products contain chemicals which, when improperly discarded, may contribute to the contamination of natural resources and water supplies. To find out if a product is potentially hazardous, read the product label and look for words such as **WARNING, POISON, CAUTION, HARMFUL, CAUSTIC FLAMMABLE, EXPLOSIVE, IRRITANT, or HAZARDOUS.**

GETTING STARTED

Ask the class to define household hazardous waste. Have the students bring in several examples or pictures of items which they think are or could be considered household hazardous waste.

PROCEDURE

1. Develop a class list of household hazardous wastes. Each student should contribute the names of ten items which they think are or could be called household hazardous wastes, and explain their rationale for choosing these items. Distribute list to all students.

2. Divide the class into small groups and assign each a set of items from the class household hazardous waste list. Using the Hazardous Waste Wheel and the DEM brochure, have each group determine:

* if the product is potentially a hazardous waste
* what toxic chemical(s) it contains and why they are harmful
* possible alternatives
* proper disposal methods.

3. Distribute the Household Hazardous Waste Audit sheet for students to complete. After discussing the results, have each student choose one alternative product and use it in their house for one week. Each student should prepare a TV or radio commercial stating the advantages and disadvantages of the product and the alternative. Have the class evaluate the effectiveness of each of the commercials.

EXTENSIONS
1. Invite a speaker to talk to the class about household hazardous waste. Contact the Office of Safe Waste Management at the Department of Environmental Management (DEM) or a local environmental group for suggestions.

2. Have students perform a school-wide "household" hazardous waste audit similar to the one done at home. Determine alternatives and proper disposal methods for toxics that are found.

3. Have the class prepare a list of alternative household products to distribute to the entire school.

Sources: Amy Ballin and Tim Greiner

HOUSEHOLD HAZARDOUS WASTE AUDIT WORKSHEET

Directions:
You are from the Massachusetts State Office of Safe Waste Management. You have been asked to conduct an audit at the home of__________________________to locate potential household hazardous substances. You will complete the audit locating all hazardous materials and then make recommendations to the family of __________________________about ways to decrease their use of consumer products containing hazardous chemicals.

Number of persons living in the house?_______________________

AUDIT FORM

Product	Location	Toxic Substance	Use
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			

HOUSEHOLD HAZARDOUS RECOMMENDATIONS FOR THE FAMILY OF

____

Prepared by____________________

Below is a list of the hazardous materials in your household. For each hazardous product listed, I have suggested an alternative or less hazardous product, a technique to reduce the hazardous product's use and, where appropriate, a proper disposal method.

Hazardous Product	Alternative Product	Reduction Technique	Disposal Method

1.____

2.____

3.____

4.____

5.____

6.____

7.____

8.____

9.____

10.____

11.____

12.____

13.__________________________________ __________________________________

14.____

THE LORAX

THEME:	The rapid use of resources could require changes in our present lifestyle
GOAL:	Students will explore the differences between necessary and unnecessary products and the impacts of excessive materialism on the environment
METHOD:	Reading and discussion
SUBJECTS:	English, Social Studies
SKILLS:	Analyzing, problem solving, researching
MATERIALS:	*The Lorax* by Dr. Seuss
TIME:	40 minutes

GETTING STARTED

What are the consequences of our throwaway habits? What do you really need to live?

PROCEDURE

1. Have students read *The Lorax*. Start a class discussion based on the following questions: How did each step of the Once-ler's developing business destroy a piece of the ecosystem? At what point did the ecosystem cease to function entirely? Why was the Super Axe Hacker invented? Why did the Once-ler ignore the Lorax's warnings? What happened to the Lorax? What management techniques could have been employed to help sustain the ecosystem and the business?

2. Have students research real-life examples of the following items in the story: Swomee-Swans, Brown Bar-ba-loots, Humming Fish, Thneeds, Smogulous Smoke, Gluppity-Glupps and Oncelers (e.g., Truffula Trees could represent tropical rainforests). Make sure they include the issues and potential solutions to the problems addressed on global, national, local, and personal levels.

EXTENSIONS

1. Have the students write their own story about our wasteful habits, modeled after *The Lorax*.

2. Have the class perform the story of *The Lorax* as a play for younger children. Students should lead a discussion after the skit about what the story was trying to say, asking the children how they might change their habits to be less wasteful.

Source: Adapted from AVR *Teacher's Resource Guide*

PLASTIC POLLUTION AND MARINE WILDLIFE

THEME:	Plastic litter in our oceans and beaches endangers the lives of seabirds, seals, marine turtles and other aquatic species
GOAL:	Students will learn about the negative effects of plastic waste on marine wildlife
METHOD:	Reading and discussion
SUBJECTS:	Biology, English, Political Science
SKILLS:	Analyzing, value judgement
MATERIALS:	"Plastics at Sea," by D.H.S. Wehle and Felicia Coleman
TIME:	One hour

BACKGROUND

When we picture litter we often think of it as something strewn on our roadsides and city streets. Yet, our oceans are becoming increasingly polluted with plastic debris which threaten many of the species that live in and around the sea. Some creatures mistake plastic bags for animals which they regularly feed on, such as jellyfish. Others become entangled in plastic six pack yokes and eventually choke to death. The effects of plastic litter on marine life will increase if people do not take action to alleviate the situation.

GETTING STARTED

Ask the students what kind of litter they usually see at the beach? Where does it come from?

PROCEDURE

1. Have the students read "Plastics at Sea" and discuss the following:

   a) In what ways does plastic litter affected wildlife?
   b) Why is plastic litter even more of a problem than other kinds of trash?
   c) Where did all the plastic come from? Is it all discarded directly by people? Why do people litter?
   d) Do you litter?
   e) What are some ways that you can protect marine wildlife and help solve the problems associated with plastic litter?

2. Have the students research some of the laws mentioned in the article (e.g., the Sanctuary Act and the Clean Water Act). Have them prepare brief papers addressing questions such as: What instigated the creation of this law? How does it apply to the problem of plastic litter on our beaches? Has it been effective?

3. As an alternative, have some students choose a species of marine wildlife that has been affected by plastic waste and research some of the following questions: How has plastic litter harmed this species? What is the primary source of the litter? What will happen if this problem continues? What must be done to eliminate the plastic waste? What can you do?

EXTENSIONS:

1. Have students write a letter to the local newspaper outlining what they have discovered and what people can do to alleviate the problem of plastic litter on our beaches and in our oceans.

2. Prepare a class display using short stories and poems written by students on the effects of plastic litter on the marine environment.

Source: Adapted from *A-Way with Waste*

Throughout the 1970s, a number of biologists studying the feeding habits of seabirds in different oceans of the world recounted the same story: the birds were eating plastic. Similar reports of plastic ingestion and of entanglement of plastic debris began to surface for other marine animals--fish off southern New England, turtles off Costa Rica and Japan, whales in the North Atlantic. At the same time, plastic particles turned up in surface plankton samples from both the Atlantic and Pacific oceans; plastic debris was retrieved by benthic trawls in the Bering Sea and Britain's Bristol Channel; and plastic pellets washed ashore in New Zealand in such large numbers that some beaches were literally covered with "plastic sand." By the close of the decade, marine scientists around the world had become aware of a new problem of increasing ecological concern--plastics at sea.

Two forms of plastic exist in the marine environment: "manufactured" and "raw." Manufactured plastic material along beaches and adrift at sea is primarily refuse from transport, fishing, and recreational vessels. In 1975, the National Academy of Sciences estimated that commercial fishing fleets alone dumped more than 52 million pounds of plastic packaging material into the sea and lost approximately 298 million pounds of plastic fishing gear, including nets, lines, and buoys.

Raw plastic materials--spherules, nibs, cylinders, beads, pills, and pellets--are the materials from which products are manufactured. These particles, about the size of the head of a wooden match, enter the ocean via inland waterways and outfalls from plants that manufacture plastic. They are also commonly lost from ships, particularly in the loading and unloading of freighters. Occasionally, large quantities are deliberately dumped into the sea.

Plastics turn up everywhere. Along portions of the industrialized coast of Great Britain, concentrations of raw particles have reached densities of about 2,000 pieces per square foot in benthic sediments. Near Auckland, New Zealand, 100,000 pieces of plastic were found every lineal feet of beach. Particles have also washed ashore on beaches in Texas, Washington, Portugal, Colombia, Lebanon, and at such remote sites as the Aleutian and Galapagos Islands.

Much of what we know about the distribution patterns and abundance of raw plastic in the world's oceans comes from plankton sampling of surface waters. Between 1972 and 1975, for example, the Marine Resources Monitoring, Assessment, and Prediction Program, a nationally coordinated program of the National Marine Fisheries Service, recorded plastic particles in plankton samples collected between Cape Cod and the Caribbean Sea. The majority of the particles were found to have entered the coast of southern New England, and the highest concentrations were usually in coastal waters. Raw plastic, however, was ubiquitous in the open ocean and especially common in the Sargasso Sea. This suggests that winds and currents are instrumental in redistributing and concentrating particles in certain oceanographic regions.

Inevitably, many animals foraging in the marine environment will encounter and occasionally ingest these widely distributed plastic materials. One of the first records of plastic ingestion appeared in 1962 for an adult Leach's storm petrel collected off Newfoundland. Four years later, researchers in the Hawaiian Islands found that the stomach contents of young Laysan albatrosses contained plastic, apparently fed them by their parents.

For the most part, these early reports were treated as curious anecdotes included in the studies of the feeding ecology of a few sea birds. During the 1970s and early 1980s, however, with the proliferation of such anecdotes, biologists are paying closer attention and were surprised to find how frequently plastic occurred in the stomach contents of certain procellariids from the North Pacific and the North Atlantic (short-tailed shearwaters, sooty shearwaters, and northern fulmars) and alcids from the North Pacific (parakeet auklets and horned puffins). Lower frequencies were reported for other Northern Hemisphere sea birds, including phalaropes, gulls, terns, and also other procellariids and alcids. The feeding habits of marine birds in southern oceans have not been studied as extensively, but plastic ingestion has been documented for several species of procellariids (petrels, shearwaters, and prions) in the South Atlantic, South Pacific, and subantarctic water. To date, approximately 15 percent of the world's 280 species of sea birds are known to have ingested plastic.

Sea birds choose a wide array of plastic objects while foraging: raw particles, fragments of processed products, detergent bottle caps, polyethylene bags, and toy soldiers, cars, and animals. Marine turtles on the other hand, consistently select one item--plastic bags. In the past few years, plastic bags have been found in the stomachs of four of the seven species of marine turtles: leatherbacks from New York, New Jersey, French Guiana, South Africa, and the coast of France; hawksbills on the Caribbean coast of Costa Rica; greens in the South China Sea and in Japanese, Australian, and Central American coastal waters; and olive ridleys in the Pacific coastal waters off Mexico. Evidence points to plastic ingestion in loggerheads as well, based on liver samples containing high concentrations of a plasticizer (a chemical compound added to plastic to give it elasticity). Polystyrene spherules have been found in the digestive tracts of one species of chaetognath (transparent, wormlike animals) and eight species of fish in southern New England waters. They have also turned up in sea snails and in several species of bottom-dwelling fishes in the Severn Estuary of southwestern Great Britain.

Marine mammals are not exempt from participation in the plastic feast. Stomachs of a number of beached pygmy sperm whales and rough-tooth dolphins, a Cuvier's beaked whale, and a West Indian manatee contained plastic sheeting or bags. In addition, Minke whales have been sighted eating plastic debris thrown from commercial fishing vessels. Curiously, plastic has not been found in any of the thousands of ribbon, bearded, harbor, spotted, ringed, or northern fur seal stomachs examined from Alaska.

The obvious question arising from these reports is, Why do marine animals eat plastic? In the most comprehensive study to date, Robert H. Day of the University of Alaska maintains that the ultimate reason for plastic ingestion by Alaskan seabirds lies in plastic's similarity--in color, size, and shape--to natural prey items. In parakeet auklets examined by Day, for example, 94% of all the ingested plastic particles were small, light brown, and bore a striking resemblance to the small crustaceans on which the birds typically feed.

Marine turtles also mistake plastic objects for potential food items. Transparent polyethylene bags apparently evoke the same feeding response in sea turtles as do jellyfish and other medusoid coelenterates, the major food item of leatherbacks and subsidiary prey of greens, hawksbills, loggerheads, and ridleys.

Sea birds, marine turtles, and marine mammals all eat plastic. So what? Perhaps ingesting plastic is inconsequential to their health. After all, cows are known to retain nails, metal staples, and strands of barbed wire in their stomachs for more than a year with no ill effects. For marine animals, however, the evidence is growing that in some cases at least, ingested plastic causes intestinal blockage. George R. Hughes of the Natal Parks Board, South Africa, extracted a ball of plastic from the gut of an emaciated leatherback turtle; when unraveled, the plastic measured nine feet wide and twelve feet long. There is little doubt that the plastic presented an obstruction to normal digestion. Similarly, a mass mortality of green turtles off Costa Rica has been attributed to the large number of plastic banana bags eaten by the turtles.

The twenty dead red phalaropes discovered on a beach in southern California, all with plastic in their digestive tracts, present a less clear case. Did the birds suffer an adverse physiological response after eating plastic or were they already under stress because of a reduced food supply and eating the plastic in a last-ditch effort to prevent starvation? The same question applies to other instances of emaciated animals that have eaten plastic. At this time, we don't have an answer.

We do know that plastic is virtually indigestible and that individual pieces may persist and accumulate in the gut. Ingested plastic may reduce an animal's sensation of hunger and thus inhibit feeding activity. This, in turn, could result in low fat reserves and an inability to meet the increased energy demands of reproduction and migration. Plastic may also cause ulcerations in the stomach and intestinal linings, and it is suspected of causing damage to other anatomical structures. Finally, ingestion of plastic may contribute synthetic chemicals to body tissues. Some plasticizers, for example, may concentrate in fatty tissues, their toxic ingredients causing eggshell thinning, aberrant behavior, or tissue damage. When highly contaminated tissues are mobilized for energy, these toxins may be released in lethal doses.

Publication of data on plastic ingestion is in its infancy. As the problem gains notoriety, it will certainly be revealed to be even more widespread than is now recognized. There are already several known instances of secondary ingestion, in which plastic consumed by animals feeding at low trophic levels shows up in higher-level consumers. The remains of a broad-billed prion, together with the plastic pellets it had ingested, were found in the castings of a predatory South Polar skua in the South Atlantic; plastic pellets found in the Galapagos Islands were traced from transport vessels in Ecuadorean ports through a food chain involving fish, blue-footed boobies, and, finally, short-eared owls.

A more obvious effect of plastic pollution is the aesthetic one. Whether we venture deep into the woods, high atop a mountain, or out on the ocean to escape the trappings of civilization, our experience of the natural world is often marred by the discovery of human litter. Even more disturbing to the spirit is the sight of a young pelican dangling helplessly from its nest by a fishing line, a whale rising to the surface with its flukes enshrouded in netting, or a seal nursing wounds caused by a plastic band that has cut into its flesh. Unfortunately, such observations are becoming more and more common, another consequence of plastics at sea.

During the last twenty years, fishing pressure has increased dramatically in all the world's oceans, and with it, the amount of fishing-related debris dumped into the sea. In addition, the kind of fishing equipment finding its way into the ocean has changed. Traditionally, fishing nets were made of hemp, cotton, or flax, which sank if not buoyed up. These materials disintegrated within a relatively short time and, because of the size of the fibers, were largely avoided by diving sea birds and marine mammals. With the advent of synthetic fibers after World War II, however, different kinds of nets came into use. These new nets were more buoyant and longer-lived than their predecessors, and some of them were nearly invisible under water.

The result of these changes in net materials has been a tragic increase in mortality of air breathing animals. A few examples are sufficient to give an idea of the magnitude of the problem. During the heyday (1972-76) of the Danish salmon fishery in the North Atlantic, the incidental catch of thick-billed murres amounted to three-quarters of a million birds annually; in 1980, 2,000 sea turtles off the southeastern coast of the United States drowned when incidentally caught in shrimp trawl nets. Incidental catch refers to nontarget animals that are accidentally caught in an actively working net. Another kind of net-related mortality is known as entanglement and refers to any animal caught in a net that has been lost or discarded at sea. Some government officials estimate that about 50,000 northern fur seals currently die in the North Pacific each year as a result of entanglement in fishing gear. Unlike working nets, which fish for specific periods of time, these free-floating nets, often broken into fragments, fish indefinitely. When washed ashore, they may also threaten land birds and mammals; in the Aleutians Islands, for example, a reindeer became entangled in a Japanese gill net.

Plastic strapping bands--used to secure crates, bundles of netting, and other cargo--are another common form of ship-generated debris. Discarded bands are often found girdling marine mammals, which are particularly susceptible to entanglement because of their proclivity for examining floating objects. The instances of seal entanglement in plastic bands has increased so remarkably in the past two decades that fur seal harvesters in Alaska and South Africa now monitor the number of ringed animals.

Sea birds that frequent recreational waters or coastal dumps are also subject to ringing by the plastic yokes used in packaging six-packs of beer and soda pop. Gulls with rings caught around their necks are sometimes strangled when the free end of the yoke snags on protruding objects. Similarly, pelicans, which plunge into the water to feed, run the risk of diving into yokes. If the rings become firmly wedged around their bills, the birds may starve.

Not all encounters with plastic prove harmful to marine organisms. Some animals are incorporating the new materials into their lives. Algae, hydrozoans, bryozoans, polychaetes (marine worms), and small crustaceans attach to plastic floating at sea; bacteria proliferate in both raw and processed plastic refuse. Plastic provides these organism with long-lived substrates for attachment and transport; in some cases, hitching a ride on floating pieces of plastic may alter an organism's normal distribution. Several species of tube-dwelling polychaetes construct their tubes of raw plastic particles present in benthic sediments. Other invertebrates, such as sand hoppers and periwinkles, find temporary homes in aggregates of plastic particles they encounter on beaches. Marine birds all over the world incorporate plastic litter into their nests, but in this case, the use of plastic may be harmful because chicks can become entangled in the debris and die.

Instances of marine animals adapting to this new element in their environment do not alter the predominantly negative effect of plastics at sea. The problem is global and will require international cooperation. Historically, the high seas have, in many respects, been considered an international no-man's land. Recently, however, perception of the ocean as a finite and shared resource has caused many nations to express concern for its well-being.

In 1970, the U.S. Congress passed the National Environmental Policy Act which, among other things, pledged to "encourage productive and enjoyable harmony between man and his environment." Subsequently, a number of laws on waste disposal were adopted, two of which affect pollution by plastics: The Federal Water Pollution Control Act (commonly known as the Clean Water Act) and the Marine Protection, Research, and Sanctuaries Act (the Ocean Dumping Act). The Clean Water Act does not specifically address the problem of persistent plastics but does require all significant polluters of U.S. waterways to obtain a federal permit, under which limits are set on, among other things, discharges of solid matter. The Ocean Dumping Act prohibits the deliberate dumping of significant amounts of persistent plastic materials at sea. Having these laws on the books, however, does not immediately solve the problem. Small-scale refuse disposal on the high seas is difficult to regulate; fishermen who claim to have unintentionally lost their nets at sea cannot be held responsible; and illegal large-scale dumping at sea is hard to detect. Granted, laws must be tightened, but enforcement is really the bigger problem.

On the international level, the problems of water pollution and litter in the oceans were highlighted at the United Nations Conference on the Human Environment held in Stockholm in 1972. The conference, with 110 nations represented, defined the need for international policy on marine pollution among coastal and maritime nations. Treaties to implement such a policy soon followed: the 1972 London Convention on the Prevention of Water Pollution by Dumping of Wastes and Other Matter (Ocean Dumping Convention), a part of which specifically prohibits marine dumping of persistent plastic material; and the 1973 London International Convention for the Prevention of Pollution from Ships (Marine Pollution Convention), which is broader in scope and regulates the control of oil pollution, packaged substances, sewage, and garbage. While neither of these treaties has been adopted by all nations, they represent a start toward global control of marine pollution.

In the meantime, the quantity of plastics in the world's oceans will undoubtedly continue to mount. Ironically, the very characteristics that make plastic appropriate for so many uses--its light weight, strength, and durability--lead to the majority of problems associated with its presence at sea. As organic material, plastic is theoretically subject to degradation by mechanical, oxidative, or microbial means. Owing to the strength of most plastics, however, mechanical degradation by wave action is generally restricted to the breaking of large pieces into smaller ones. Photooxidation and microbial action are limited by plastic's high molecular weight and its antioxidants, ultraviolet light stabilizers, and biocide additives, which effectively immunize it against degradation. The longevity of plastics in seawater is not known, but on the beach, particles may last from five to more than fifty years.

Given plastic's long life and projected annual increases in production, one thing is clear--the rate of plastic deposition in the marine environment will continue to be higher than the rate of disappearance. In a study of the accumulation of plastic on the beaches of Amchitka Island, Theodore R. Merrell, Jr., of the National Marine Fisheries Service recorded that 550 pounds of plastic litter were added to less than a mile of the beach in one year. He also found an increase of more than 250 percent in both the number and the weight of plastic items washed ashore over a two-year period.

Outside the realm of laws and treaties, solutions to the problem can come from both inside and outside the plastic industry. The technology to manufacture biodegradable plastics is available. In fact, one of the beauties of plastic is that its properties can be altered and its life expectancy prescribed. Alaska has already taken steps toward reducing plastic litter by requiring that six-pack yokes be made of a self-destructing compound. Another, but perhaps less workable solution, given the logistics and expense involved and the degree of business and public cooperation required, lies in recyclable plastics. At the very least, all countries should require that the discharge of raw plastic materials from industrial plants be reduced by filtering outflow before it enters waterways. A recent decline in the uptake of plastic by marine organisms in southwestern England has been attributed, in part, to the efforts of one of the major contaminating plants to filter, collect, and reuse raw particles present in its effluent.

Consumers share with industry the responsibility to reduce the amount of plastic in the sea. Recreational boaters, beach-goers, and commercial fisherman all discard plastic refuse. Preferably, no trash plastic-bands, netting, or other debris should ever be tossed overboard or left on a beach. If six-pack yokes or strapping bands must be discarded at sea, the rings should be cut first so that they pose less of a threat to marine animals.

The first step in combating plastic pollution is to alert both industry and the general public to the gravity of the problem and the need to do something about it soon. Education alone cannot solve the problem but it is a beginning. Public awareness of a problem, combined with the resolve to correct it, can bring dramatic results.

Source: Reprinted with permission from "Plastics at Sea" by D.H.S. Wehle and Felicia Coleman, *Natural History Magazine*, American Museum of Natural History, Vol. 92, No. 2, February 1983, pp. 21-26.

THE RESOURCE PROTECTION GAME

THEME:	Human activity can affect our environment in a variety of ways
GOAL:	Students will recognize the ecological impacts of different solid waste management practices on natural resources
METHOD:	Resource Protection Game
SUBJECTS:	Science, Social Studies
SKILLS:	Analyzing, problem solving
MATERIALS:	"Resource Protection Game" handout; "Natural Resource Cards" handout
TIME:	45 minutes

GETTING STARTED

Ask the students in what ways their activities affect the environment?

PROCEDURE

1. As an introduction, review with the class the earth's natural cycles and how human activities can affect these cycles and our natural resources.

2. Have students read through the list of sample situations. Discuss what effects they might have on our natural resources and some possible alternatives to each of these situations.

3. Divide the class into six groups. Distribute natural resource cards to each group and have a spokesperson read about the resource to the rest of the class. The task of each group is to develop a strategy to protect that resource in each of the given situations.

4. Each group should answer the following questions in terms of their resource and each situation:

   a) How does this situation help your natural resource?
   b) How does it harm your natural resource?
   c) Is this situation good or bad? How might it be improved? What alternatives might you suggest?

Source: Reprinted with permission from *Oscar's Options*

RESOURCE PROTECTION GAME

SITUATIONS:

1. A mandatory curbside recycling program has just begun in your town. Residents must separate their newspapers, aluminum, steel cans, and glass for recycling. It is now illegal to send bags of leaves and yard waste to the landfill.

2. A local cheese factory produces several hundred pounds of whey waste each week. The milk haulers dump the whey illegally in local swamps, streams, and on unused fields when they think no one is looking.

3. A local developer wants to build 360 new condominiums on the side of one of the highest peaks in the state.

4. After heavy rains, untreated sewage and rainwater contaminated with automobile oil flows into water bodies used by Massachusetts residents for recreation and as reservoirs.

5. A print shop generates forty pounds of chemical waste each month, which does not have to be reported to the state or disposed of with other regulated hazardous wastes. The print shop owner waits until he can fill several fifty-five gallon drums and then dumps them at the local landfill.

6. A fishing party out on the Connecticut River discards beer bottles, plastic sandwich bags, orange peels, and other litter overboard before the end of the trip. A few plastic six pack rings and fishing lines were thrown in as well.

7. The landfill in your city is scheduled to close in six months. The city has decided to build a new landfill on the other side of town.

8. A trash-to-energy incinerator plant is being built in a nearby town. This plant will supply your town with some of its electricity. Some of the ash produced will be deposited in your town's landfill and may be toxic.

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NATURAL RESOURCE CARDS

AIR	WATER
Clean air is essential to all living things. Any smoke or other chemicals which enter the air result in air pollution. Protect the air from all forms of air pollution.	Fresh water serves two important functions. All living creatures need it to survive, and many need it for their homes. Salt water also supports many forms of life. It is essential to protect both kinds of water.
SOIL/MINERALS	**FORESTS AND PLANTS**
Soil contains minerals and nutrients needed by all living things. However, there is also a limited supply of these minerals on our earth. The soil and its minerals must be protected.	Plants are an important natural resource. They are beautiful and are a source of food and shelter for many animals. Plants also help purify our air with the oxygen they give off during photosynthesis. We must protect them.
FISH AND WILDLIFE	**PEOPLE**
Fish, insects, and wildlife are essential members of the ecosystem. They provide us with food and recreation opportunities. All living things depend on these creatures daily, and we must protect them.	Human beings are a natural resource. We are part of many food chains and affect the ecological balance of the earth. We are also consumers of natural resources and must conserve them for future generations.

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SOLID WASTE MANAGEMENT IN MASSACHUSETTS

SOLID WASTE MANAGEMENT IN MASSACHUSETTS

THE PAST

How was garbage handled and disposed?

Trash disposal is an ancient problem which has typically been dealt with in the cheapest, quickest way. From the 1700s until the mid-1950s, communities in the Commonwealth relied on open burning and dumping as methods for solid waste disposal. Trash from Massachusetts was disposed of in unpopulated areas considered unfit for development, such as river banks, wetlands, floodplains, marshes, swamps, and bogs.[1]

By the mid-1800s unsightly dumps were causing a number of health problems such as attracting rodents and other pests which transmit infectious diseases. As populations grew, so, too, did refuse accumulation, and the question of what to do with household garbage intensified. By the late 1800s, communities began passing ordinances to clean up refuse areas.[2]

At the turn of the century, most communities in the United States dumped their waste in marshes and wetlands. These areas were considered unsuitable for development and could be purchased at very low prices by local haulers and municipal governments.[3] The prevailing belief was that the soil would act as a natural filter, and that as the waste residues percolated through the ground the dilution process would render them harmless. No one anticipated the consequences of groundwater contamination and the effects on public and private water supplies. Garbage dumps were frequently established in areas where supplies of fresh groundwater are "recharged" by rainfall, the very places where many municipalities were also locating drinking water pumps and wells.

In the 1930s much waste was burned in open pits to reduce its volume before burial. Open pit burning, however, caused its own problems and there were frequent landfill fires. First, surrounding neighborhoods lived with continuously smokey air. Second, the fire department always seemed en route to put out landfill fires. In fact, landfill fires used to be so abundant that they were used by fire departments to train newly-enrolled firemen.[4]

Communities responded by passing ordinances limiting open burning to specific areas. As the need for disposal grew, the availability of marginal land for disposal decreased and many cities built incinerators, further reducing the need for land to bury garbage.[5]

What legislation led to regulating solid waste facilities?

Public awareness of the importance of land-use preservation grew dramatically during the 1960s and 1970s. Attention was focused on wetlands, floodplains, and other water resources, which were the very areas where household garbage and industrial waste were being dumped and buried. Most communities in the Commonwealth still disposed of their waste in sanitary landfills, a term that came of age during this period. (See Chapter III for more information on landfills.)

Lobbying efforts on the part of environmental groups such as the National Audubon Society and the Sierra Club led to legislative action, including passage of the National Solid Wastes Act in October 1965. This Act required all states to accept federal guidelines structuring regulations for solid waste management and disposal. Each state could add to these requirements as it saw fit.[6]

Massachusetts increased the federal standards in 1969 with passage of the Solid Waste Disposal Act. This Act established the authority of the Massachusetts Department of Public Health to write and enforce regulations governing the design and operation of "sanitary landfills." This responsibility now belongs to the Department of Environmental Protection. The law and the regulations:

* outlawed "open dumps;"
* required that sanitary landfills be sited, designed, operated and closed in such a manner as to protect public health, safety, and the environment; and
* prevented "the occurrence of conditions of air, land, and water pollution and assisted in the abatement of such conditions when and where such pollution occur."[7]

Approximately thirty municipalities closed their landfills during the first year after the Massachusetts landfill disposal regulations went into effect in 1971. The remaining municipalities either upgraded their landfills if they could afford to, or continued to operate them without meeting state regulations. In most cases, alternative options for disposal were not readily affordable.[8]

The establishment of the U.S. Environmental Protection Agency (EPA) in 1970 heralded further environmental and legislative reforms, reflecting a growing public understanding of environmental issues. The EPA's mission was to administer and enforce anti-pollution laws directed towards air and water. The Clean Air Act of 1970 and the Clean Water Act of 1972 set standards and compliance procedures for industrial polluters and, for the first time, established the authority to levy fines against companies that failed to comply. Compliance with the new federal air emissions standards under the Clean Air Act required incinerators be retrofitted with costly pollution control devices. In Massachusetts all incinerators, except two, were closed rather than taking on the high cost of compliance.[9]

How did solid waste management become a public priority?

Amid growing environmental concerns and projections of dwindling space for trash, the decade of the 1980s saw solid waste management receive increased public attention. In Massachusetts, two of the more important legislative efforts addressing the garbage crisis were the Massachusetts Container Recovery Law (or Bottle Bill), which passed by referendum in 1982, and the Solid Waste Act of 1987, a $260.5 million bond appropriation for state programs.

On January 17, 1983, Massachusetts became the eighth state in the nation to implement mandatory deposit legislation for certain beverage containers. Glass, plastic, metal, aluminum and bi-metal containers holding beer and other malt beverages, carbonated drinks, and artificially carbonated mineral waters are subject to the law. Many containers including those for dairy products and natural fruit juices are exempt. All are required to carry a deposit label before being sold. Empty containers are returned for refund to any redemption center which has agreed to accept containers or any retail outlet which has sold the same brand, type or size of container within the past sixty days. The Bottle Bill's original purpose was to reduce litter and conserve raw materials, though it has become the initial motivator for many people to separate and recycle material.

The 1987 Solid Waste Act (M.G.L. Chapter 584) constitutes the largest state appropriation ever allocated to address the Commonwealth's solid waste management problems. The Act provides financial assistance to cities, towns, and other public bodies, and creates several non-monetary requirements to ensure that solid waste disposal facilities do not threaten the environment or public health. It also provides grants and no-interest loans to public entities establishing new solid waste disposal facilities.

THE PRESENT

How is our solid waste handled today?

Today, 63 percent of the Commonwealth's municipal solid waste is landfilled in one of 164 active landfills. Twenty-five of these are constructed with liners to prevent contaminated water from exiting the landfill into surrounding soil. The remaining 139 are older, unprotected facilities.[10]

The other major solid waste disposal option is to burn trash in combustion facilities. Massachusetts currently has ten trash-burning plants. Two of these are older municipal incinerators, two are "refuse derived fuel" plants which shred the trash prior to burning it, and six are "mass-burn" plants. Some of these facilities burn as little as 240 tons of trash per day, while the largest burns 1,800 tons of trash per day. These plants burned approximately 31 percent of all the household and commercial solid waste produced in Massachusetts in 1988 and 48 percent in 1989.[11]

Currently only 7 percent of the Commonwealth's municipal solid waste stream is recycled through the Bottle Bill and other recycling and composting programs. One hundred twenty-one Bay State communities (34 percent) have recycling programs and over 80 have passed mandatory recycling ordinances. Composting programs are active in over 120 cities and towns.

Chapter III provides details on all the solid waste disposal methods listed above.

What environmental safeguards exist for solid waste facilities?

Responding to public concern about potential threats to the environment and public health, state and federal officials have taken steps to strengthen environmental safeguards at all solid waste facilities, including landfills, combustion facilities, and recycling plants.

The Department of Environmental Protection (DEP) is the Commonwealth's lead agency for regulating solid waste facilities. DEP's Division of Solid Waste Management:

* establishes standards for the siting, construction, and operation of solid waste facilities that protect public health and the environment;

* issues permits and regulates existing facilities to ensure they comply with these standards; and

* levies penalties for illegal dumping.

State-of-the-art landfill technology now includes standards for construction, operation, and environmental monitoring. Landfill operators are required to install impermeable clay or synthetic liner systems, groundwater monitoring devices, and gas collection equipment.

Safeguards at combustion facilities have also been established, requiring all new plants to have state-of-the-art air pollution equipment installed in their smokestacks to control emissions.

What is the conventional cost of solid waste disposal?

The cost of building a new landfill or expanding an old one has risen drastically in recent years. Depending on geologic and other conditions, construction costs may range from $465,000 to $1 million per acre. In addition to the land and construction expense, these costs include air pollution control equipment, collection, insurance, and transportation.[12]

As recently as ten years ago, the cost of solid waste collection and disposal was minimal, ranging from $5 to $20/ton, and was a relatively small percentage of overall municipal budgets. In Massachusetts today, garbage disposal costs an average of $58/ton, although some communities pay as much as $100/ton. The cost of waste disposal has become the third largest municipal expenditure after schools and roads. These climbing costs provide local governments with an incentive to look beyond landfills and incineration facilities for solutions to their trash problems.

THE FUTURE

What is integrated solid waste management?

Solutions to the trash problem are not simple. The Commonwealth's choice--an integrated solid waste management system--is an approach that processes and disposes of the components of the waste stream in order to capture their full economic value and to protect the environment.

Integrated solid waste management benefits both the environment and the local economy. First, the environment is protected by reducing the potential for air, surface water, and groundwater contamination, and by decreasing the rate at which land is consumed for disposal. Second, municipalities can save money because recycling and composting generally are less costly than combustion or landfilling.[13]

For maximum protection of the environment, the Massachusetts Department of Environmental Protection advocates the following approach to address the trash problem:

Source Reduction: Both the toxicity and the volume of waste can be reduced by having industry design and sell products that are durable, use less packaging, and have a minimum of toxic ingredients. Consumers can buy selectively and reuse products in the home when possible. All these efforts contribute to source reduction.

Recycling: Recycling, including the composting of food and yard wastes and the reusing of products outside the home, prevents potentially useful materials from being buried or burned and extends the lifespan of landfills by preserving valuable space. What was once treated as "waste" becomes a major component in the manufacture of new products. Using recycled materials--newspapers instead of new trees to make paper--saves energy and natural resources.

Waste Combustion or Resource Recovery. Waste that cannot be reduced or recycled but can be safely burned, should be incinerated in a combustion facility equipped with state-of-the-art pollution control equipment. Such facilities reduce the volume of non-recyclable, non-renewable waste and convert the heating value of garbage to steam or electricity.

Landfills. Landfilling--to handle wastes that cannot be reduced, recycled, or burned--should be the last resort as a waste disposal method. Landfills should be equipped with proper liners and leachate collection systems to protect the environment. DEP's goal is to create a system in which no waste is landfilled without first being processed and reduced in volume.

Recognizing that communities need assistance to comply with this waste management plan, the state offers the following help:

* technical assistance in all areas of solid waste management; and

* grant programs for feasibility studies and project proposals which could be developed into a comprehensive regional solid waste plan.

How might a community institute an Integrated Solid Waste Management System?

Take as an example the hypothetical town of Carneysville, which wants to comply with the goals of the state's new Masterplan by establishing an integrated solid waste management system. It generates approximately 2,000 tons of municipal solid waste a year (30 percent is commercial and 70 percent is residential). Carneysville is responsible for the collection and disposal of all 2,000 tons.

Following the list of preferred disposal options in the Masterplan, the town adopts an ambitious source reduction program in order to decrease its waste stream by 200 tons per year, or 10 percent.

The major business in the community, a shampoo manufacturer, is asked to consider measures to use less packaging for its shampoo bottles. This will reduce the trash consumers throw out and minimize the amount of discarded material resulting during the production process. The company also decides to initiate an office paper recycling program in their administrative offices.

Consumers (both in households and in businesses) are encouraged to shop selectively, avoiding disposable goods and excess packaging. The area supermarkets begin to sell their shopping bags to encourage customers to bring their own bags to the market. Some citizens write to a direct mail company in New York City to request the removal of their names from junk mail lists.

Next, the town takes an inventory of what can be recycled. They calculate that they can recycle close to 600 tons of paper, glass, metals, plastic, and leaf and yard waste a year, 30 percent of their waste stream.

Carneysville joins forces with neighboring communities to form a regional recycling committee. A private contractor, attracted by the large projected volume of recyclable materials generated by the towns, constructs a regional processing center, a Materials Recycling Facility (MRF). The communities sign a contract to deliver their recyclable newspaper, glass, metal, and plastic to the facility, for processing and subsequent sale.

Residents participate in the new recycling program by separating their paper, glass, metal, and plastic into specially marked containers. The remaining non-recyclable trash is disposed of as usual in the trash bin.

The town also initiates a comprehensive leaf and yard waste composting program. During the fall and spring, the town provides curbside collection service. In addition, citizens can bring in their materials by car or truck. This organic leaf and yard waste is put in large piles. Through the composting process, micro-organisms break down the materials into a nutrient-rich soil like substance called humus which is used by the town for landscaping.

The town conducts two household hazardous waste collection days each year for materials that can not be safely disposed of by conventional methods. These materials include drain and septic tank cleaners, nail polish, pesticides, medicines, and paint.

Of the remaining 1,200 tons of refuse, the town estimates that 1,000 tons, or 50 percent of the total municipal solid waste generated, can be safely burned at a neighboring combustion facility. Carneysville negotiates a flexible contract with that facility which allows the town to adjust the tonnage it provides for burning based on its recycling rate.

Three-hundred tons of garbage--100 tons from the recycling facility or incinerator (excluding the ash residue), and 200 tons of waste that could not be reduced, recycled, or burned--are disposed in the Mom and Pop, Inc. landfill facility located in town.

The result: The 2,000 tons of municipal solid waste originally generated and landfilled by Carneysville has been significantly reduced by establishing an integrated solid waste management program.

ENDNOTES

1. Geri Lambert. *Groundwater Protection: The Policy Crisis of Solid Waste Management in Massachusetts.* (Unpublished Masters Thesis, Tufts University, February 1986), p. 21.

2. *Ibid*, p. 22.

3. *Ibid*, p. 24.

4. *Ibid*, p. 25.

5. *Ibid*, p. 26.

6. *Ibid.*

7. Commonwealth of Massachusetts, M.G.L. 310, April 21, 1971, Department of Environmental Quality Engineering, Section 19.00, "The Disposal of Solid Wastes by Sanitary Landfill." Adopted under the provision of Chapter 150A Section 111, General Laws, as inserted by Chapter 839 of the Acts of 1970.

8. Lambert, *Groundwater Protection*, p. 28.

9. *Ibid*, p. 29.

10. Commonwealth of Massachusetts, Department Of Environmental Protection. *The Commonwealth's Solid Waste Masterplan: Towards a System of Integrated Solid Waste Management*, Second Draft, October 1989, p. 5.

11. *Ibid.*

12. National Solid Waste Management Association. *Landfill Capacity in the Year 2000*, Special Report, 1989.

13. Commonwealth of Massachusetts, Department of Environmental Protection, *Masterplan*, p. 9.

THEN AND NOW

THEME:	Our waste stream has changed over time, reflecting technological advances, increased wealth, and social behavior
GOAL:	Students will understand that changes in the composition of the waste stream depends on our habits and lifestyles
METHOD:	Research and completion of worksheet
SUBJECTS:	Language Arts, Social Studies
SKILLS:	Analyzing, comparing, researching
MATERIALS:	"Then and Now" worksheet
TIME:	One hour, plus additional time for research

GETTING STARTED

Ask students how life today differs from life in the 1800s. How would these differences impact the kind and amount of waste produced?

PROCEDURE

1. Ask students to make a list of items they use every day, (e.g., kitchen appliances, clothing, tools, machines, types of transportation, food, etc.).

2. As a class, go over the students' lists. Do any patterns emerge? What kinds of lifestyles require these products? What do these products tell you about our priorities?

3. Have each child pick one item from their list and research its equivalent from one or two hundred years ago. Have students complete the "Then and Now" worksheet and draw pictures or construct an artifact of their product for a class display.

4. Discuss the differences between the products used during each time period. Ask the class: What do the products tell you about the lifestyles and the way people spent (or spend) their time during each time period? Can you tell what was (or is) important to the people in each time period? How might these differences affect the generation and disposal of solid waste?

EXTENSIONS

1. Have the students, individually or in groups, invent an alternative to a modern convenience which uses few, if any, non-renewable resources, is designed to last a long time, and will not adversely effect the environment when its useful life is over.

Source: Adapted from AVR *Teacher's Resource Guide*

THEN AND NOW WORKSHEET

1. Answer the following questions for your item and its historical equivalent.

a. Is it made from natural or synthetic components?

NOW:
THEN:

b. Is it made from renewable or non-renewable resources?

NOW:
THEN:

c. Does it use energy from renewable or non-renewable resources to operate?

NOW:
THEN:

d. Does it last a long time or is it disposed of quickly?

NOW:
THEN:

e. Is it hand-crafted or mass produced?

NOW:
THEN:

f. Is it something that you wouldn't want to do without or something you wouldn't mind giving up?

NOW:
THEN:

THEN AND NOW WORKSHEET (Cont.)

g. Is it biodegradable or non-biodegradable?

NOW:	
THEN:	

h. Does it contain any hazardous materials?

NOW:	
THEN:	

i. Is it necessary for survival or is it a convenience?

NOW:	
THEN:	

2. List some "luxuries" from the past that are considered necessities today.

3. What changes in lifestyle would result from the following:

    a. loss of a non-renewable resource

    b. drastic increase in the price of a non-renewable fuel

    c. irreparable damage to a renewable resource (e.g., groundwater contamination, depletion of forest reserves, animal extinction)

Source: Reprinted with permission from *AVR Teacher's Resource Guide*

UNDERSTANDING PACKAGING OVER TIME

THEME:	Our culture encourages the use of disposable products and packaging
GOAL:	Students will learn that disposable products and excess packaging create more waste than reusable or recyclable products
METHOD:	Reading and comparing products and packaging
SUBJECTS:	Language Arts, Social Studies
SKILLS:	Analyzing, comparing, critical thinking
MATERIALS:	*Ox Cart Man* by Donald Hall; other books depicting packaging and products from different cultures or time periods; one of the following books depicting products of today: The Wright Group Big Books (*To Market, To Market; What's for Lunch?; I Want Ice Cream*) or The Rigby Big Books (*Breakfast in Bed; Green Bananas*)
TIME:	One week

GETTING STARTED

Ask the students what is the function of packaging. Did people living during the Colonial period need packaging? Did they use the same kind as we do?

PROCEDURE

1. Read aloud or have students read the *Ox Cart Man* and discuss the following questions: What is packaging? What is it used for? What did the family in the book use for carrying and holding food and other items? What products did they buy? What resources were used to make those products? What did they do when something was broken, used up, or worn out?

2. Have the class read one of the stories depicting home life today. Discuss the same or a similar set of questions.

3. As a class, compare the two books. How does our lifestyle differ from that of Colonial Americans? How are they the same? What kinds of waste might Colonial Americans have had more of? What kinds of waste do we have more of? Why are so many of our products and packages designed for short-term use and quick disposal?

EXTENSIONS

1. Have the students interview a parent, grandparent, or another adult about what they used for products or packaging when they were children as compared to today.

2. Plan a "no-trash lunch" using old fashioned packaging such as baskets, tins, and cloth napkins. Compare packaging to what we typically use today.

Source: Kristen Walser

IF TOYS COULD TALK

THEME:	Over the past century the items we use have changed significantly, as have the nature and composition of our waste
GOAL:	Students will understand how the products we use today differ from those used by our parents and grandparents
METHOD:	Interviewing and discussion
SUBJECTS:	Language Arts, Social Studies
SKILLS:	Analyzing, comparing, interviewing
MATERIALS:	Pictures or examples of antique toys and modern-day toys
TIME:	Two hours, plus additional time for interviews

BACKGROUND

Most products, including toys, have changed significantly over the years. At one time most toys were made from natural materials such as wood. Handmade country toys like whirligigs, bean shooters, yo-yos, and tops were very popular. Over time, commercially manufactured toys like wooden Lincoln Logs and Tinker Toys became available. In the 1960s, plastic toys began to dominate the market, and the demand for hula hoops, frisbees, Lego, toy guns, and plastic models increased steadily. Today, battery-operated and electronic toys, along with video and computer games, are quite popular. Changes in the way toys are made, in what they can do, and in the materials used to produce them, reflect changes in our society.

GETTING STARTED

Make a list of the students' favorite toys. What are most of the toys made of?

PROCEDURE

1. Ask the students if they have had a favorite toy that didn't last very long. What happened to it? What was it made of? Ask students to bring in toys that are broken or to be thrown away. What are they made of? How long did they last? Are there any patterns or similarities between the broken toys? Discuss how some of these toys could be redesigned to last longer. How might these toys be fixed or made into new toys?

2. Have the students interview an older person about toys that were available when they were children. Another option is to invite a senior citizen to class for a group interview or to take a field trip to a nursing home or senior citizen center. Have the class develop a list of questions that the students might ask the person they decide to interview. Questions could include:

* What was your favorite toy when you were little?
* How many toys did you have? What were they made of?
* Who made them? Where did you get them?
* How long did they last? Could they be fixed if they broke?
* Would it have been cheaper to fix an old toy or buy a new one? Why?
* Could you fix a broken toy at home, or did someone else have to fix it?
* If a broken toy could not be repaired, what did you do with it?
* How are the toys sold today different from those that you had?

3. Have the students answer their own questions. Discuss the differences between their answers and those of the people they interviewed. Ask the students to make some generalizations about their lives and those of their ancestors. What do these differences imply? How might these differences affect our natural resources?

EXTENSIONS

1. Take a field trip to a museum or a historical society to look at their old toy collection.

2. Find out how some old toys were made and make them in class. Students could also invent new toys made out of natural materials.

3. Have each student choose to research and write a report about toys that were popular in a different time period or culture (e.g., Native American toys, Egyptian toys).

Sources: Adapted from AVR *Teacher's Resource Guide*; Wisconsin *Recycling Study Guide*

DECADES OF DISPOSAL: THE GREAT DEBATE

THEME:	Trash disposal methods have changed over the past 250 years
GOAL:	Students will evaluate how solid waste disposal methods have evolved to reflect new technology and changes in the types of waste being generated
METHOD:	Research and debate
SUBJECT:	English, Science, Social Studies
SKILLS:	Analyzing, public speaking, researching, role playing
MATERIALS:	None
TIME:	One class period, plus additional time for class debates

GETTING STARTED

As a class, develop a list of factors that might influence the kinds of trash disposal methods employed.

PROCEDURE

1. Have the students research population growth in Massachusetts since 1650. Discuss the relationship between increased human population and the amount of solid waste being produced. How might the amount and composition of solid waste be influenced by changes in lifestyle? What impacts have increased numbers of people and the amount and complexity of the waste stream had on the environment?

2. How have disposal methods changed over time? Why? (Some reasons include changes in the waste stream, technological progress, and new knowledge regarding the environmental impacts of waste and particular disposal methods.) Point out that the way we dispose of our waste has evolved in response to changes in our society.

3. Divide the class into small teams. Assign each group a time period and have them research trash disposal method(s) used in Massachusetts during that era. Choose time periods that include or follow a major breakthrough in solid waste technology, a social or scientific discovery, or the passage of new legislation. Students should explore the impetus for the transition, disposal methods used before and after the change, and the pros, cons, and environmental impacts of these methods.

4. Have each group present a debate of the issues surrounding solid waste disposal during their time period. The facts used in the debate should reflect the information and technology available at that time. Each student in the group should play a different role representing a character in their time period. For example, characters in a Colonial period debate might include a town father, a store keeper, a farmer, a doctor, and a person who lives in town. Characters involved in the era surrounding the passage of the bottle bill might include a supermarket manager, an environmentalist, a legislator (for and against the bottle bill), a state resident, a liquor store owner, etc.

5. Debates should be presented chronologically. At the end of each debate, initiate a short class discussion to summarize and record the key points. At the conclusion of all the debates, copy and distribute the lists of key points. Students will have created a Massachusetts Solid Waste Disposal history book.

EXTENSIONS

1. Have each group research a waste disposal method used today (source reduction, recycling, composting, combustion, landfills), and stage a class debate on the pros and cons surrounding each method. Explore the validity of each method for particular types of waste. Discuss the rational behind the Department of Environmental Protection's prioritization of these methods. Introduce the concept of Integrated Solid Waste Management and discuss the importance of combining the various methods to suit the environmental and financial situations in the Commonwealth.

TRASH THROUGHOUT THE AGES

THEME:	The composition of our trash differs from that of our ancestors
GOAL:	Students will gain an understanding of how our use of natural resources and generation of waste has changed over time
METHOD:	Poster or essay with discussion
SUBJECTS:	Art, Science, Social Studies
SKILLS:	Critical thinking, inferring, researching
MATERIALS:	Construction paper; pictures
TIME:	One hour

BACKGROUND

Looking back into the lives of previous generations reveals many interesting facts about how their lives were different from those we live today. Not only did people make do without the many technological advances we now take for granted, but they generated less waste by re-using and recycling many items (even if they didn't call it by those names). Comparing our lifestyles and habits to those of past generations reveals much about how modern society lives and suggests ways we could reduce our use of natural resources and the amount of waste we generate.

GETTING STARTED

Have the students list some of the modern conveniences (e.g., frozen foods, disposable diapers, etc.) we have today and what their ancestors might have used instead.

PROCEDURE

1. Divide the class into small groups and assign each a different time period (Native American or Arrival of the Pilgrims, Colonial Settlement, The California Gold Rush, World War II, etc.). Have each group research their time period and make a poster illustrating the kinds of trash items they would have generated. Each group should explain their poster to the class. What kinds of things can you tell about a culture by examining its waste? What do the differences in trash indicate about the lifestyles of the people living then?

2. Make a time line and mount the posters at the appropriate period. Have students write an essay on how and why the materials Americans throw away have changed over time.

3. Ask the class what people did before the convenience products we use today (e.g., disposable diapers, scotch tape, microwave ovens, plastic wrap, plastic soda bottles, etc.) were available. Give each student a card with the name f an object we use today and have them come up with an alternative product used in a different time period but which does the same thing. How would the waste generated by the alternate differ from that generated by the product used today?

EXTENSIONS

1. Have the students interview their parents, grandparents, or other adults to find out how the products they used as children, and the type and amount of trash they generated, are different from today.

2. World War II was a period of full-fledged recycling in the United States. Have the students research what types of things were recycled and write an essay on how this affected the amount and type of waste being generated. Why have things changed?

3. Tell the students they are archaeologists from the Year 3000 and have discovered an old landfill from the Year 1990. What sorts of items would they find? What conclusions could they draw about our society from looking at its trash?

4. Have the students (individually or in groups) select a foreign country and research the amount and types of trash it generates. Have students report back to the class and discuss how American society and habits differ from those in other countries. What can different countries learn from one another?

Source: Adapted from AVR *Teacher's Resource Guide*

SOLID WASTE DISPOSAL METHODS

SOLID WASTE DISPOSAL METHODS

SOURCE REDUCTION

What is source reduction?

Source reduction refers to those practices which reduce waste and pollution during the production process, resulting in less waste and toxic material. It can also be defined as practices which consumers follow to select products which are durable, reusable, or have less impact on the environment during use.

Much household solid waste comes from packaging. Today, nearly $1 of every $10 Americans spend for food and beverages pays for packaging.[1] Approximately one-third of the state's MSW stream comes from packaging. As a result, plastic bags and bottles, metal cans, glass jars, cardboard and paper containers swell the waste stream. Disposable products also significantly contribute to the waste stream.

Frequent stylistic and technological changes in our society have increased the amount of waste we produce. Products deliberately designed for single or very limited use before disposal, contribute to our throwaway lifestyle. Many people believe that the public's demand for convenience has caused the proliferation of packaging and single-use products, but this is only partially true. The quantity of waste has increased not only from packaging but from some uses of paper (e.g., direct-mail advertising, oversized newspapers, phone books) and single-use products such as disposable diapers. In addition, yard wastes make up a large portion of municipal solid waste in many areas.[2]

Social customs and lifestyle preferences lead to the generation of excessive waste. Reducing the amount of trash produced will require changes in the attitudes of most citizens. Product manufacturers and consumers must assume joint responsibility for waste generation and make changes in production design practices and in purchasing decisions.[3]

In response to the nation's solid waste capacity shortage, strategies to reduce packaging are being devised and implemented by government officials, industry representatives, and consumers. The following strategies will help to achieve source reduction of packaging waste:

- reducing the total volume of disposable packaging material generated for domestic, commercial, industrial and government use;

- reducing the disposal impact of packaging waste by changing to more environmentally benign packaging material;

* increasing the recyclability of packaging products that cannot be reduced at the source; and

* increasing the recycled content of packaging products.

Source reduction also involves efforts to reduce environmentally harmful ingredients contained in household products. Solvents found in paints, paint strippers, and some cleaners evaporate and can react with sunlight to create smog. Restrictions on the content of solvents in consumer products are being considered by some state governments as a means of fighting smog. Drain, toilet, tub, and tile cleaners, and other toxic chemical products flushed down the drain during normal use can harm septic systems, sewers, and sewage treatment systems. Chemicals discharged from these systems can contaminate sewage sludge, rivers, lakes, and oceans, harming wildlife and natural ecosystem functioning.

Educational programs to inform and motivate consumers are critical to the success of any source reduction program. The durability of products and/or ease of recycling should be higher on our list of priorities. We can make choices for the environment rather than for our personal convenience. It is not always easy to change our attitudes and behaviors, but the consumer choices we make today will have a direct effect on the quantity of waste we must dispose of tomorrow.

HOW CAN THE AVERAGE CONSUMER PRACTICE SOURCE REDUCTION?

1. Select Products Carefully. At the store, consider the environmental impact of each purchase you make. What is the product made of? Is it safe for the environment? Can it be reused or recycled? Is there a more benign alternative product or type of packaging? Do you really need the product or its excess packaging?

2. Be Picky About Packaging. At the store, reach for the product packaged in recyclable materials such as paper, cardboard, glass, and aluminum. "Biodegradable" plastic bags, now widely offered at supermarkets, merely break up into smaller pieces of plastic, and only under special conditions.

3. Avoid Overpackaging. If the packaging isn't necessary to protect the product, or if it's simply eye-catching, buy the less packaged alternative. It will probably cost less too.

4. Fast Food. If you are a regular coffee take-out patron, bring your own thermos or cup. If you are buying one product from a fast food restaurant and do not need a bag, ask not to be given one.

5. Avoid Disposables. Don't buy products manufactured purposely for automatic disposal such as razors, lighters, plastic or paper plates, etc. Do buy items designed for reuse: thermos jars, rechargeable batteries, cloth napkins, and sponges.

6. Buy in Bulk. Avoid overpackaging and save money too. Bring your own container with you to the store and buy in bulk rather than pre-packaged items. Store brands and generic goods are often less packaged than others.

7. State Your Views. Talk to the store manager about your product and packaging preferences. Suggest that your grocer sell strong shopping bags or string bags designed for reuse. Encourage in-store recycling programs. Educate fellow consumers. Patronize businesses that offer recyclable products, less packaging, and the opportunity to buy in bulk. Write or call your state and federal officials to lend your support to legislation that favors recycling and reduces unnecessary and non-recyclable packaging.

8. Reuse Things. When you no longer need clothing or household items, consider giving them to charity.

9. Repair Things. Don't discard them. By patronizing neighborhood repair shops, you'll help the local economy.

10. Compost. Feed your garden and it will feed you. The Department of Environmental Protection's Division of Solid Waste Management has a free brochure to backyard composting.

11. Parents - Teach Your Children to Practice Waste Reduction. Children may be highly susceptible targets for the lure of overpackaged goods, but they're quick learners and we can teach them to do it right from the start.

Source: Adapted from City of Berkeley, California, Recycling Division. *"PRECYCLE" Campaign: Reject, Reuse, Recycle...Consumer Tips for Reducing Waste*, 1989.

RECYCLING

What is recycling?

Recycling is the conversion of discarded material into useful commodities, basically turning trash into new products. Recyclable materials include paper, glass, metals, plastics, food wastes, and leaf and yard wastes.

Although recycling will not solve all of our solid waste problems, it is one means of handling significant portions of our waste stream with relatively little detriment to the environment.

How does recycling work?

The three arrows of the standard recycling logo represent the three components of the recycling process.

* Separating and collecting recyclable products from other trash.

* Processing such products so that they can be substituted for virgin raw materials at manufacturing plants.

* Remanufacturing recyclable material into useful commodities, usually as part other products (e.g., cardboard can be reused in packaging, or glass processed to make reflective paint).

Step One: Collection and Separation

Residential recycling programs are generally run or contracted for by state and local governments or non-profit organizations. Commercial enterprises are responsible for setting up their own recycling collection programs. Generally, the most effective programs follow current trash collection systems as much as possible. Residential and commercial programs typically fall into one of four basic patterns.

Household Separation/Curbside Collection. This type of program is usually run by municipalities and is appropriate for communities which have curbside trash collection. Individual households are encouraged (or required by ordinance) to sort materials, such as bottles, cans, and newspapers, before putting them at the curb for collection. Materials may be placed in special containers or bagged separately from ordinary trash.

Drop-off Centers. These are designated collection points where people bring recyclables. This is the most common form of recycling in the country.

Buy-Back Centers. These centers pay consumers for bringing in recyclable materials.

Commercial Collection. These programs are run by private companies that collect recyclables from businesses, offices, institutions, schools, and industries that generate large quantities of the same types of waste, such as cardboard or white paper.

Step Two: Processing Recyclables

Recyclables are processed to prepare them for market. Processing occurs after the recyclables have been collected and involves a variety of steps usually beginning with sorting and segregation by material type or color, and removing contaminants (e.g., the metal rings on glass bottles). Materials may then be crushed, shredded, flattened, or baled depending on industry requirements and shipping considerations. For example, one paper mill may be able to accept newspaper and magazines, while another will only be able to use the newspapers. Materials that do not meet market specifications are impossible to sell and may end up in either the landfill or the incinerator.

Because processing is a specialized activity, and because end-markets tend to be large industrial factories, recycling is more apt to be cost effective when processing is conducted on a regional basis where large quantities of material can be amassed and quality can be assured. After the materials have been processed, they are marketed and transported to their end destination.

Step Three: Closing the Loop -- Re-manufacturing and Marketing

Recycling is not complete until the materials are re-manufactured into desirable products and resold as new goods. Recycled materials removed from the waste stream for re-manufacturing are frequently referred to as post-consumer materials. Buyers of processed post-consumer materials are usually large industrial manufacturing firms that use the recycled materials as a substitute for raw ("virgin") materials. Listed below are several examples of products that can utilize recycled materials in the manufacture of new products, and the natural resources those materials replace.

RECYCLED MATERIALS	END PRODUCT	CURRENT RAW MATERIAL USED
Newspaper	Boxboard	Pulp from trees
Glass	Glass	Sand, soda ash, limestone
Aluminum	Aluminum	Bauxite ore
Tin Cans	Steel	Iron ore, coal
Plastic	Plastic	Plastic resins from oil and natural gas

Recycled materials compete with well-established sources of virgin materials. That is why quality control in processing must be high. Marketing recycled materials requires identifying specific companies that can use recycled materials to make new products. Once these companies are found, then the recycled materials are priced so that the buying company can afford to use them instead of the traditional supply of virgin raw materials.

How do recyclable materials get processed into products?

Paper and other Wood Fiber Products. Paper is made from the fiber of trees. Certain grades of used paper can be processed and made into new paper or other fiber products. Once it has arrived at a factory, recycled waste paper is first processed in a pulper. Water and chemicals remove inks and contaminants and turn the paper into a soft, wet material called pulp. The pulp is sifted through screens (to remove staples, paperclips, etc.) and washed. Clean pulp is mixed with clean water until it becomes a thick, white substance. This is spread into thin layers on a screen, heated, dried, and smoothed on a series of rollers to form sheets of clean finished paper.[4]

Recycled paper is used primarily by mills that produce newsprint, stationery, towels, tissues, napkins, insulation, roofing paper, packaging, and paper board, the grey cardboard found on the backs of pads or in packaging new shirts.[5]

The value of recycled paper is related to several factors: the quality of the fiber in the paper, the level of contamination in the recycled paper, the ability to re-manufacture the paper into new products, and the availability of mills to accept the recycled paper. For example, a piece of computer printout, made from bleached chemical pulp, can be remade into a number of different grades of paper, from high-quality office paper to paperboard. On the other hand, newspaper made from unbleached ground wood pulp can only be used to make new newsprint, paperboard, or cellulose insulation.

Glass. To be fully useful to manufacturers, recycled glass must be separated by color--green, amber, brown and clear--and be free of contaminants such as metal tops and rings, foil and paper labels, and plastics. Ceramics and window glass, which have an entirely different composition from container glass, are considered contaminants to recycled container glass. Recycled glass is crushed into small pieces less than one-half inch in size called cullet and mixed with sand, soda ash, and limestone in large furnaces to produce clean glass. Molten glass is poured into molds to produce the shape of the end container. If the cullet is free of contaminants, it is considered a desirable, acceptable alternative to the basic raw materials of glass making. Manufacturing with recycled glass offers significant energy (and therefore cost) savings since recycled glass melts at a lower temperature than virgin materials.[6] Other markets for recycled glass include fiberglass manufacturing and as a substitute for aggregate in road building.

Aluminum. Aluminum comes from bauxite ore which contains large amounts of alumina. After separating alumina from bauxite, the aluminum is extracted from the alumina by an electric process which consumes a tremendous amount of energy. Melted aluminum is cast into ingots which are heated and molded into different shapes such as cans, foil, etc. Recycled aluminum is shredded, remelted and cast into ingots and mixed with "virgin" aluminum before being shaped. Once produced, aluminum can be recycled indefinitely. Manufacturing from recycled aluminum requires only five percent of the energy needed to produce aluminum ore, providing manufacturers with tremendous savings in energy costs.

Tin Cans and Ferrous Metals. Recycled metals are generally shredded or compacted, cleaned, and remelted. Most residential recycling of ferrous metals--iron and steel products--focuses on the recovery of tin cans. Tin cans are composed of roughly 1 percent tin (used as a coating) and 99 percent steel. Tin cans most often are sent to a de-tinning factory where the chemical separation of tin from steel takes place. The two materials are then marketed to different manufacturers for use in new products. Increasingly, tin cans are being sent directly to steel mills where they are mixed with other raw materials to make new steel.

Plastics. The recycling of plastics, while relatively new, is a rapidly growing technology. Because all plastics are manufactured from oil and natural gas, recycling these materials not only preserves landfill space, but also saves energy because new oil and gas are not used to produce new plastic resins. There are two kinds of plastics which differ in their reaction to heat: thermoset and thermoplastics. Thermoset plastics harden permanently in the presence of heat and cannot be remelted or remolded, making them unlikely candidates for recycling. Thermoset plastics are used in products for building and construction, transportation, and furniture. In contrast, thermoplastic products can undergo repeated melting and remolding. Thermoplastic resins are commonly used for rigid containers such as dairy, detergent, and cosmetic bottles, trash bags, toys, rope, utensils, flooring, "styrofoam," upholstery, and pipes. To recycle thermoplastic materials, scrap plastic must be reduced to granules, pellets, or powder, which are then marketed as feedstock to plastics molders.

Large clear soft drink bottles, and the heavier plastic milk, shampoo, oil and detergent bottles make up most of the plastics recycled today. These products are manufactured from two resins and comprise about 80 percent of the plastics in the residential waste stream.

Soft-drink bottles are made from polyethylene terephthalate (PET). Recycling this type of plastic involves shredding the bottles, followed by washing and contaminant removal. A common product made from recycled PET is the fiberfill used in pillows, jackets, sleeping bags, and automobile seats. Other uses include insulation, shower stalls, floor tiles, automobile bumpers, taillight covers, and power tool housings.[7]

Gallon and half-gallon plastic bottles made of high density polyethylene (HDPE) resin now dominate the milk and juice industries. When this plastic is reclaimed by plastic recycling companies it can be remolded into flower pots, trash cans, automotive mud flaps, kitchen drainboards, beverage bottle crates, and pallets.[8]

The plastics industry has also developed technology and products that do not require the separation of resins for recycling. These mixed-resin plastics are used as boat docks, auto curb stops, park benches, horse stalls, picnic tables, railroad ties, and fencing. Research into the separation of mixed plastics and its uses is continuing.

How much does recycling cost?

One misconception about recycling is that it generates revenue. Not so! This premise was based on the past when relatively small amounts of materials were being collected, primarily in volunteer drives. This type of recycling was not done for waste management purposes but to raise funds for community programs.

Today recycling is a means by which millions of tons of materials are managed. Extensive labor and equipment is required to collect, process, and sell such large quantities of materials. While there will be revenues from the sale of recycled materials communities cannot, and should not, count on those revenues to entirely offset the costs of recycling. On the other hand, recycling programs, if properly structured, can be less expensive than combustion or landfilling, especially as the cost of these traditional disposal methods continue to rise.

While communities generally will not realize profits from recycling they can realize savings in the overall cost of solid waste management. To illustrate, assume a town currently pays $60/ton to dispose of its solid waste at a combustion facility. It can recycle a ton of waste for $40. Thus, for every ton recycled at $40, the town could avoid the additional $20 it would pay for conventional disposal.

How is the Commonwealth approaching regional recycling?

The cornerstone of the Commonwealth's Recycling Plan is the establishment of large-scale regional processing plants called Materials Recycling Facilities (MRFs). The function of these centers is to accept large quantities of recyclable materials and to upgrade them into high quality feedstocks that will be acceptable and economically-attractive alternatives to virgin industrial feedstocks (raw materials). Such facilities provide the missing link between community collection of recyclable materials and manufacturers by producing consistent quantities of high-quality materials for industrial use. In turn, these supplies create a consistent demand for such recyclable materials.

The state's first MRF, located in Springfield, opened in January 1990 and is the largest project of its kind in the country. It serves 85 communities in the four western counties, or approximately 700,000 residents. DEP's recycling program in western Massachusetts involves a cooperative effort between the state and participating communities. The state's 240 tons-per-day plant is available at no charge to participating communities, other than the cost to haul their recyclables to Springfield. In addition, the state provided most of these cities and towns with household recycling storage containers, specialized recycling vehicles to perform curbside pickup, and/or large roll-off containers to be placed at landfills or transfer stations in those communities implementing drop-off programs. To participate, communities are required to pass mandatory recycling ordinances, collect recyclables from residences and deliver them to the MRF, and conduct ongoing public education activities.

The program is simple and is designed to be compatible with the trash disposal system residents currently use. Residents separate their recyclables, which include glass, metal "tin" and aluminum cans, newspaper, cardboard and mixed paper items, and place them in the container provided by the state. Bottles and cans should be rinsed, but caps, rings, and labels may be left on. Newspaper, cardboard, and mixed paper items are bundled or boxed separately. All other trash (e.g., food-contaminated papers, plastic, diapers) are disposed of in the usual manner. In communities where citizens have curbside pickup, the recycling bin and bundled paper are set out for pickup on the designated collection day. For communities providing trash disposal at a landfill or transfer station, recyclable materials are deposited in the divided containers at the site.

The MRF is operated by a private recycling company under a five-year contract with the state. The private operator is responsible for processing the recyclables and marketing them. There is no charge to the communities for materials brought to the MRF.

In addition to the western Massachusetts project, several groups elsewhere in the state are exploring regional recycling strategies. Long-term possibilities being investigated include large scale recycling programs through curbside collection of different materials, extensive market cooperative programs, permanent drop-off stations, and development of private materials recycling facilities (MRFs) by localities.

Many municipalities have also initiated recycling programs on their own. Communities that have implemented curbside programs include the towns of Lexington, Bedford, Chelmsford, Marblehead, Montague, and Erving and the cities of Brookline, Newton, and Peabody. Dozens of other municipalities are seeking to establish new recycling drop-off centers or expand existing ones. Profiles of several community recycling programs are included with the 7-12 Activity, "Designing a Collection System."

STUDENT ACTION

Why should we start a School Recycling Program?

Establishing a white paper recycling program at your school is an action students can take to demonstrate that they, as individuals, understand that their attitudes and actions contribute to the solid waste problem in their community. They can show that as responsible citizens they are willing to play an instrumental role in solving these problems. Students will acquire not only organizational skills but a sense of the importance of individual action in environmental issues.

A School Recycling Program Benefits Students, Teachers, School and the Community.

The benefits to students are that they:

* get a chance to put into action the values and attitudes promoted in solid waste and recycling activities;
* become involved in a practical, hands-on, rewarding project;
* see how classroom skills can be applied to solving real problems;
* learn management skills needed in future careers; and
* benefit the school and the entire community by recycling.

A recycling program benefits teachers and the school by:

* reducing the total amount of solid waste by recycling the high percentage of paper waste a school typically generates;
* promoting cooperation among teachers, students, and the administration;
* encouraging teachers to include topics with immediate practical application in their curriculum; and
* demonstrating to the community the school's commitment to protecting the environment and to minimizing its management expenditures.

A community benefits by:

* reduced school and community solid waste disposal costs; and
* involving parents in the education of their children.

How do we develop a white paper recycling program?

Because schools typically create a high percentage of paper waste, a white paper recycling program can drastically reduce the amount of solid waste it produces and, in turn, cut disposal costs. The following step-by-step procedures will assist you in establishing this project.

Step 1. Commitment

Carefully consider the extensive commitments in time and equipment needed for the success of a long-term recycling program. Both students and faculty need to be involved. Remember that the goal of any school recycling is not only to increase recycling and reduce waste, but to strengthen recycling in the community and region.

Step 2. Conduct a Survey

Determine first and foremost if there is a nearby recycling facility which could support your program. Contact recycling businesses to see what services and payment are available (e.g., bins, materials accepted, individual specifications, hauling of recyclables, current prices paid, etc.). Contact DEP's Division of Solid Waste Management for names of vendors listed in its *Recyclable Material Markets and Waste Disposal Sites Directory*.

Step 3. Implementing the Program

A. Designate a coordinator for the recycling program. School project leaders should contact student groups which might be interested in accepting responsibility for program initiation and operation. Consideration should be given to developing a structure for ongoing, year-to-year management of the recycling program.

B. Establish a system for separating, collecting, and storing paper:

1. Designate local deposit locations.
2. Acquire and install properly-labeled containers.
3. Designate who will collect the recyclables.
4. Determine when collection will occur.
5. Provide ample storage space, preferably with truck access. Contact the local fire marshall regarding logistics and to ensure you are in compliance with local ordinances.

C. Educate the school community about the program:

1. Notify the entire staff including maintenance staff.
2. Hold an informational meeting to explain and demonstrate the procedures.
3. Display posters.
4. Prepare notices to send home with students.
5. Publicize your efforts and successes in the local newspaper.

Sources: Adapted from AVR *Teacher's Resource Guide*; *A-Way With Waste*; *Here Today, Here Tomorrow*

EXAMPLES OF SCHOOL RECYCLING PROGRAMS IN MASSACHUSETTS

Milton Academy, Milton, Massachusetts

Milton Academy is an independent day and boarding school for children in grades K-12. It has a total of 950 students. In 1988, a group of students from the high school organized an environmental organization called "The Lorax" and instituted a white and newspaper recycling program on campus. Although the group is supervised by a faculty advisor, the program is maintained entirely by the students. During its first year, the students recycled approximately five tons of paper. Presently, the "Lorax" consists of 60 members, 30 to 40 of which attend meetings regularly. It expects to recycle twelve tons of paper by June 1990. Complementing the students' successful paper recycling program, the organization has petitioned the school to purchase recycled paper, helped rid the school of styrofoam, and started a glass recycling program.

Over the past 18 months the students have overcome several obstacles in running their program:

1. Cardboard boxes were first used to collect paper, but soon fell apart under the weight. The program now uses nearly sixty 32-gallon "Roughneck" trash receptacles throughout the campus, and 100-pound capacity woven plastic grainbags for transportation.

2. There was no central location for storing the paper. Paper had to be left in individual receptacles until collection. Receptacles soon filled up with waste paper and became cumbersome and unsightly. In the Fall of 1989, the group was given $500 in discretionary funds to buy a storage shed.

3. An overzealous custodial staff emptied the recycling boxes into the trash because of confusion about the program. The administration has promised to insist on cooperation from the maintenance staff.

4. Transporting the materials off campus to the paper vendor proved difficult. The school has vans which could be driven only by a faculty member and were not available to the group at predictable times. The administration has now agreed to allow the group use of a van on a consistent basis.

From the beginning, the students approached implementation of the project with stubborn determination. The committee is doing extensive advertising on campus and realizes that it must keep a high profile to make recycling a school endeavor. The "Lorax" committee has acquired organizational skills and also a sense of the importance of individual action in environmental issues.

(Source: Mark Fraioli and Beka Sturges, Student Coordinators)

Philips Academy, Andover, Massachusetts

Phillips Academy in Andover, an independent preparatory high school, started one of the first student run paper recycling programs in the Commonwealth. The program is student directed and supervised and is funded through the school.

Every Sunday night a representative collects paper from each of the sixty campus-wide dormitories, and delivers it to a specified dumpster where it is weighed. The dormitory which brings in the most paper is given a reward, such as pizza for the entire dormitory. The school is now exploring the purchase of an acre of land in the Amazon to be preserved under the winning dormitory's name.

During 1989, the school collected over 153,000 pounds of paper. With the school paying $65/ton for trash disposal, total estimated savings from the paper recycling program during its two-year existence is over $18,000.

(Source: Lila Nichols, Student Coordinator)

COMPOSTING

What is composting?

Composting is a natural process in which micro-organisms break down organic materials such as leaves and yard waste into a soil-like substance called humus. This substance can be used to stabilize or enrich soil. In nature, this process can take a number of years but under man-made conditions, with proper levels of moisture and air circulation, composting can take from six weeks to over a year. It is a versatile process that can be conducted at sites of varying size, and utilizing different levels of technology.

About 65 to 70 percent of the solid waste stream is composed of organic material such as paper, cardboard, wood products and paper sludge, and yard wastes, that is grass clippings, leaves, brush, and tree prunings. Leaf and yard wastes--which make up 18 percent of the household waste stream--are more efficiently processed by composting than by landfilling or burning. Since yard wastes are relatively clean, biodegradable material, landfilling them is unnecessary and wastes precious landfill space. The high moisture content of this type of waste inhibits complete burning in a combustion facility.[9]

Composting is a vital part of the Commonwealth's integrated solid waste management strategy. It offers significant environmental and economic benefits and enables communities to make more effective use of incinerator and landfill capacity. The benefits of composting are:

* reduced volume of waste to be incinerated or landfilled.
* avoided solid waste disposal costs.
* minimal environmental impacts.
* production of beneficial material--humus--which improves the productive potential of soil.

What are the state's future composting goals?

The Commonwealth has embarked on an aggressive four-year strategy for developing leaf composting programs. DEP's primary goal is to divert leaves and yard waste collected from disposal facilities to compost operations. DEP provides workshops and detailed technical assistance to help communities and regions establish their own programs. As of 1989 approximately 120 municipalities composted leaf and yard waste. DEP also offers an educational brochure for citizens entitled "Backyard Composting," which provides information regarding personal backyard composting projects.

COMBUSTION

What is a combustion facility?

Combustion facilities burn wastes to reduce their volume, thus conserving valuable landfill space. A 1,500 ton-per-day facility can typically achieve 75 percent waste reduction; the leftover ash material is then landfilled. The three technologies employed by facilities in Massachusetts are mass-burn, refuse-derived fuel (RDF), and incineration. Mass-burn and RDF facilities are frequently referred to as waste-to-energy facilities because they convert heat generated in the combustion process into electricity.

Mass-burn plants burn solid waste just as it is received at the facility. In this technology the furnace is lined by a wall filled with water which is transformed into steam during the garbage combustion process. The steam is then sent to a turbine generator where it is converted to electricity. The electricity is sold to a utility or neighboring commercial business to offset a portion of the cost of the facility.

The other waste-to-energy technology, Refuse-Derived Fuel, uses a different type of furnace and boiler to generate steam. Waste processing--separating ferrous metals, such as steel and cast-iron, then shredding the remaining trash into fairly small, uniform pieces--occurs prior to combustion. The separated metal is recycled. This pre-screening of the metals combined with the shredding process creates a more homogeneous and consistent fuel for burning.

Incineration, the third type of combustion technology used in the state, simply burns trash without producing electricity. Incinerators have been operating in Massachusetts since the late 1800s while mass-burn and RDF facilities are more modern technologies and have been operating since 1975.

New standards for burn facilities in Massachusetts require additional air pollution control equipment to remove ash particles and gaseous materials from the air emitted from the smoke stack. Massachusetts also requires that the toxic ash residue left after the combustion process be disposed of in landfills reserved exclusively for ash disposal. These "mono-fills" are equipped with liners and leachate collection systems. Combustion facilities cannot be permitted under the Commonwealth's rules and regulations unless they have a guaranteed ash disposal capacity for twenty years.

What is the future role of this technology?

Over the past decade the public has expressed increased concern over air emissions and the disposal of toxic ash residues. While major air pollutants and particulates have been significantly reduced by scrubbers and other air pollution control devices, heavy metals, acid gases, and organic compounds such as dioxins and dibenzofurans are still emitted into the air.

Combustion ash contains heavy metal particulates such as cadmium and lead which are trapped by the air pollution equipment when trash is burned. The better the air pollution control equipment, the greater the concentration of metals in the ash. Operational handling requirements are becoming increasingly vigorous to protect workers and to ensure that the ash is not released into the environment during its transfer from the burn facility to the ash mono-fill.

Industry is presently researching potential uses for the ash residue, including its addition to concrete products for embankments, road-paving materials, pre-cast blocks, and other construction projects, and its use as a landfill cover. Before state regulators certify such uses in the regulatory process, however, these products must undergo further testing.[10]

LANDFILLS

What is a landfill?

A landfill is a site constructed for the disposal of solid wastes.

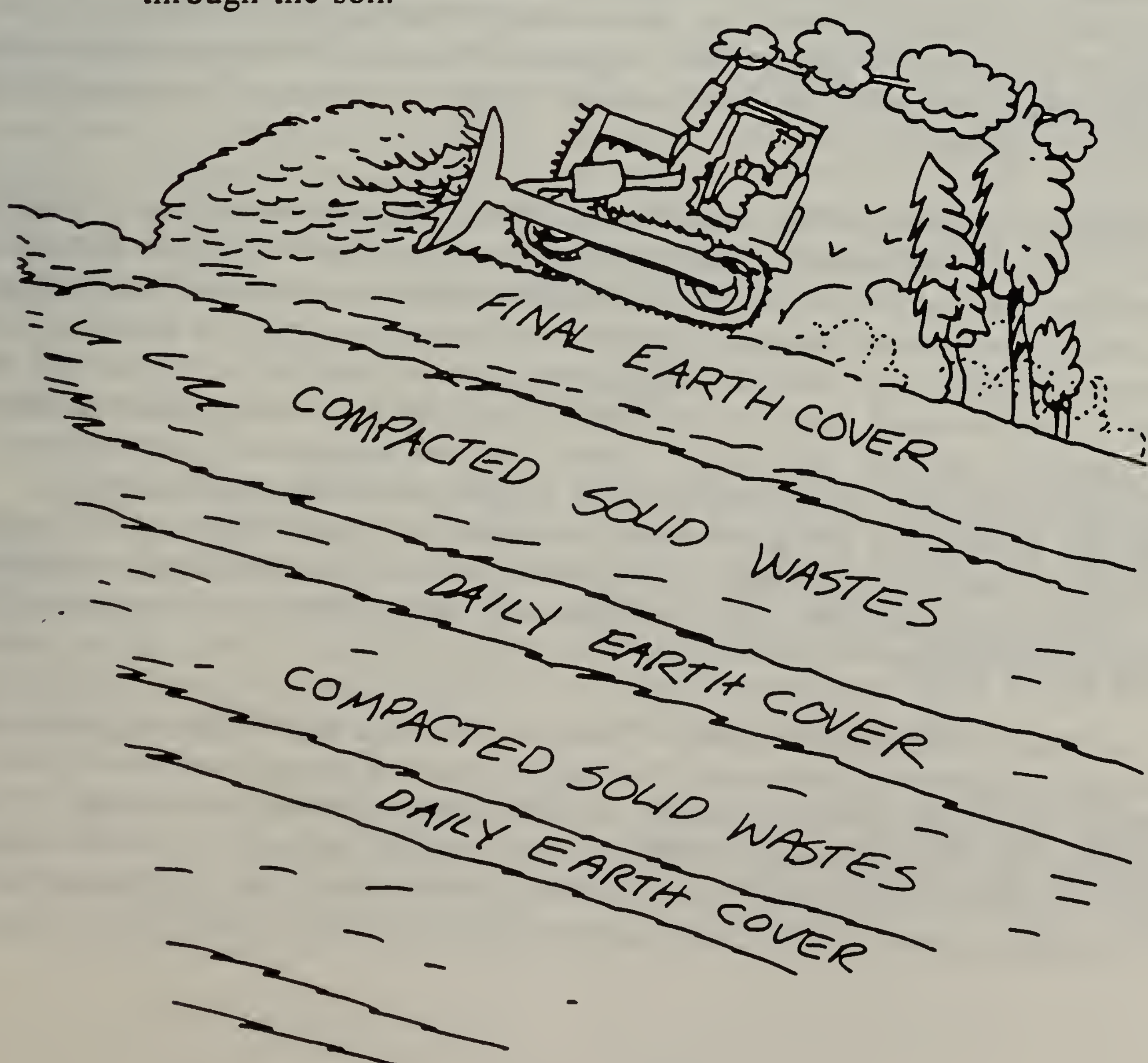
After garbage is dumped into a landfill, it is spread in thin layers, compacted to the smallest volume, and covered with at least six inches of soil. A daily cover of soil prevents blowing litter, and maintains sanitary conditions.

Solid wastes placed in sanitary landfills undergo a number of simultaneous biological, physical, and chemical changes. Among the more important of these changes are:

* the biological decay of organic material, either aerobically (in the presence of oxygen) or anaerobically (in the absence of oxygen), which produces gases (primarily methane) and water drainage called leachate;

* the chemical oxidation of materials; and

* the escape of gases from the refuse and lateral movement of the gases through the soil."[11]



The engineering goal of modern sanitary landfills is to prevent groundwater contamination, thereby protecting the environment and avoiding the creation of a nuisance or hazard to public health and safety. Barriers and collection systems are installed to isolate the disposed waste and to prevent waste-contaminated rainwater from moving off the site.

State-of-the-art landfills are lined with an impermeable barrier designed to prevent liquid in the landfill called leachate, from flowing into the ground. Liners may be constructed of a nonporous clay material, plastic, or a combination of these materials. Collection pipes lie on top of this barrier layer within a drainage layer to facilitate removal of leachate. Construction costs, including clay, plastic liner material, drainage material and labor range from $120,000 to $150,000 per acre.[12]

What are the environmental impacts of landfills?

Groundwater and Leachate. The principal environmental concern raised by landfills is the contamination of groundwater. Groundwater is found beneath most land surfaces, and accumulates after precipitation such as rain and melting snow percolate down from the surface. Geologists call this percolating process "groundwater recharge" and the places where it occurs, "recharge areas." Once groundwater reaches a saturated or impervious layer underground, it begins to move slowly by the force of gravity through interconnecting surfaces until it reaches a "discharge area", where it seeps flows out into a wetland, spring, river or pond to become part of the surface water. Since these areas are crucial to our environment it is imperative that our groundwater not become contaminated.

With the disposal of any solid waste comes a by-product known as leachate. Leachate is a combination of liquid generated from the decomposition of solid waste and precipitation that has entered the landfill through percolation. If substances such as paint products, household cleaning supplies, pesticides, batteries, or motor oil are present in a landfill, their harmful ingredients may be dissolved or suspended in the leachate. Contaminated leachate can vary in make-up depending on the garbage content of any particular landfill. The rate at which leachate travels along the surface, contaminating tributary ponds and streams, or percolates downward towards groundwater depends on the grade of the land and soil composition. On Cape Cod, for example, the typical hydrogeologic conditions consist of permeable soils and high water tables. These conditions virtually guarantee that wastes deposited on the land will end up in the groundwater.[14]

In Massachusetts, as in most of North America, a significant proportion of precipitation recharges groundwater by soaking into the ground and eventually percolating down into the water table. A large amount of leachate can be created by precipitation that filters through landfills. For example, a five-acre landfill with an average infiltration rate of twenty-one inches of precipitation per year, could generate over 2.75 million gallons of leachate annually.[15]

Biological and chemical reactions in a landfill influence the composition of leachate. Mounds of refuse offer dark, warm environments attractive to bacteria. When organic compounds are broken down by bacteria, many of the simpler compounds that are formed are acidic. When these substances dissolve in water that seeps through a landfill, they make the water acidic. This increases the water's ability to slowly oxidize heavy metals such as iron, copper, and mercury, adding concentrations of metals to the leachate.

If substances such as pesticides, cleaning products, or paints are discarded in landfills, the degree of contamination of leachate can increase. Products like these contain synthetic organic solvents which can pollute the environment and threaten human health. Examples of organic solvents include toluene, acetone, benzene, vinyl chloride, and carbon tetrachloride.

As landfills are filled, physical pressure builds from the increasing weight of compacted trash and condensed water. Hydrologic pressure squeezes water out along the paths of least resistance, called avenues of seepage. Pressure from methane gas rises at the same time that gravitational pressure pulls water downward. This downward flow may eventually reach groundwater sources, underneath the site itself. Leachate contact with groundwater converts drinkable fluids to contaminated water with various decaying organics, bacteria, heavy metals, and toxic chemicals.

As a landfill ages, leachate production and its composition changes. In general, most components of leachate become more dilute over time. Organic decomposition products are at their highest concentration during the first three to five years of leachate production, and decrease thereafter. Synthetic and petroleum-based organic solvents tend not to break down in landfills, but continue to be released for long periods of time. Similarly, the concentration of metals in leachate does not seem to decrease over time. Levels of metals and non-degrading organic solvents may need to be monitored even long after a landfill has been capped and closed.[16]

What is methane and why is it a problem?

Methane gas forms in landfills as a result of the decomposition of organic material. It is both flammable and toxic, and can cause undesirable environmental impacts. Landfill gas can move through refuse and surrounding soils to migrate away from the landfill. Methane gas has accumulated in buildings by entering through cracks, construction joints, sub-surface utility service openings and almost any other weak spot in basement walls or building floors. Controlling methane gas is a high priority when managing landfills because of the danger of explosion and fire.[17]

If there is concern about methane gas migrating off the landfill site, probes are installed into the ground to monitor gas pressure, migration patterns, and methane concentrations. If engineering controls are necessary, systems such as passive vents or gas pumping systems are employed.

Passive systems rely on natural pressure and convection mechanisms to vent the landfill gas to the atmosphere. A gravel-filled trench excavated around the outside of the landfill intercepts gas that is moving through the soil to escape through the gravel to the surface.

Active gas collection systems remove methane from the landfill or surrounding soils by literally pumping it out of the ground. These systems may provide migration control or recover methane for energy recovery purposes. Landfills that employ active gas collection systems are usually quite large in size or generate large quantities of methane. The Fresh Kills Landfill in New York, the largest landfill in the world, also has the largest methane recovery system.

What happens to inactive and abandoned landfills?

The majority of currently active landfills in Massachusetts will close over the next five years either because they have reached their capacity to receive waste or because of environmental concerns.

Once a landfill is filled to capacity, the entire area used for solid waste disposal must be closed or "capped" with an impervious layer of material. This minimizes the amount of precipitation seeping into the landfill and therefore reduces leachate production. As an integral part of constructing the cap, vents are inserted to allow gas from interior regions of the landfill to escape. Similar to construction costs for a state-of-the-art landfill, proper closure is an expensive procedure, ranging from $80,000 to $100,000 an acre.[18]

The post-closure phase of landfill management extends for at least fifteen years. Post-closure monitoring insures that the integrity of the landfill's final cover, liner(s), and groundwater or gas monitoring systems is maintained. Once landfill settling and environmental dangers have been addressed, the former landfill site might be reclaimed as a recreational area, such as a park or ball field.

What is the future of landfilling in the Commonwealth?

The Commonwealth has set a goal of phasing out the disposal of unprocessed municipal solid waste at landfills by the year 2000. Instead of being a primary solid waste disposal source, landfills will provide capacity for materials that cannot be recycled, composted or burned.

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WISE USE OF PAPER

THEME:	Many of our daily habits are wasteful regarding the use of paper
GOAL:	Students will recognize how much paper is wasted and how it accumulates over time
METHOD:	Collecting and weighing paper, graphing the results
SUBJECTS:	Math, Social Studies
SKILLS:	Analyzing, comparing, measuring
MATERIALS:	Waste paper; two cardboard boxes; scale
TIME:	Two weeks

GETTING STARTED

Ask the students how much paper they think they use? How much do they think they waste?

PROCEDURE

1. Each day have the students place in boxes all paper that would normally have been thrown away. In one box, place paper that has been completely used (i.e., written on both sides). In the other, pile paper that has been only partially used or not used at all.

2. At the end of the day select a student to weigh each stack of paper and have the class graph the results.

3. Follow this procedure every day for a week and discuss the following: Were you surprised at the amount of paper that was wasted? What is the effect of this waste on our natural resources and landfills? How can people change their habits so that there is less waste?

4. Repeat the same activity for a second week. How different were the results? List on the board the different ways the students tried to conserve paper. Are there other items that are sometimes thrown away before they are completely used?

EXTENSIONS

1. Using the results obtained above, have the class determine how much paper it would waste in a month? in a year? How much paper would the class save in a month or in a year if it reduced its paper consumption by one-half? by one-quarter?

2. Working in small groups have the class list the paper products they use at home or at school. In a parallel column, have them list products that could be used in their place (e.g., dishcloths instead of paper towels or handkerchiefs for paper tissues).

Source: Adapted from *A-Way with Waste*

TRASH TO TREASURE....

THEME:	Reusing materials before they are thrown away can conserve landfill space and natural resources
GOAL:	Students will realize they can reduce the trash load by redefining waste as a potential resource
METHOD:	Creating a class treasure chest
SUBJECTS:	Art, Language Arts, Social Sciences
SKILLS:	Creating, observing, value judgement
MATERIALS:	Trash can; old box; scraps of fabric, yarn, paper, ribbons, etc.; egg cartons; glue; scissors
TIME:	45 minutes

GETTING STARTED

Does everything that we throw away have to be trash?

PROCEDURE

1. Fill the trash can with the various scrap items and explain to the class that these are things which would normally have been thrown away, never to be used again.

2. Have the children come up one at a time and ask them to select several items out of the trash can. Have students use these materials to create whatever they want--a picture, a sculpture, jewelry, etc.

3. With the leftover materials decorate the old box to make it look like a treasure chest and have the students to come up and place their new "treasure" in the chest.

4. Point out that the garbage can is now empty. The students have both reduced the amount of garbage that has to be disposed of and reused it to make something new.

EXTENSIONS

1. Read aloud the poem "Johnny." Ask the class to think of other items at school or home that could be reused instead of being thrown away. Have the students create drawings to illustrate these objects and how they would be used in new ways.

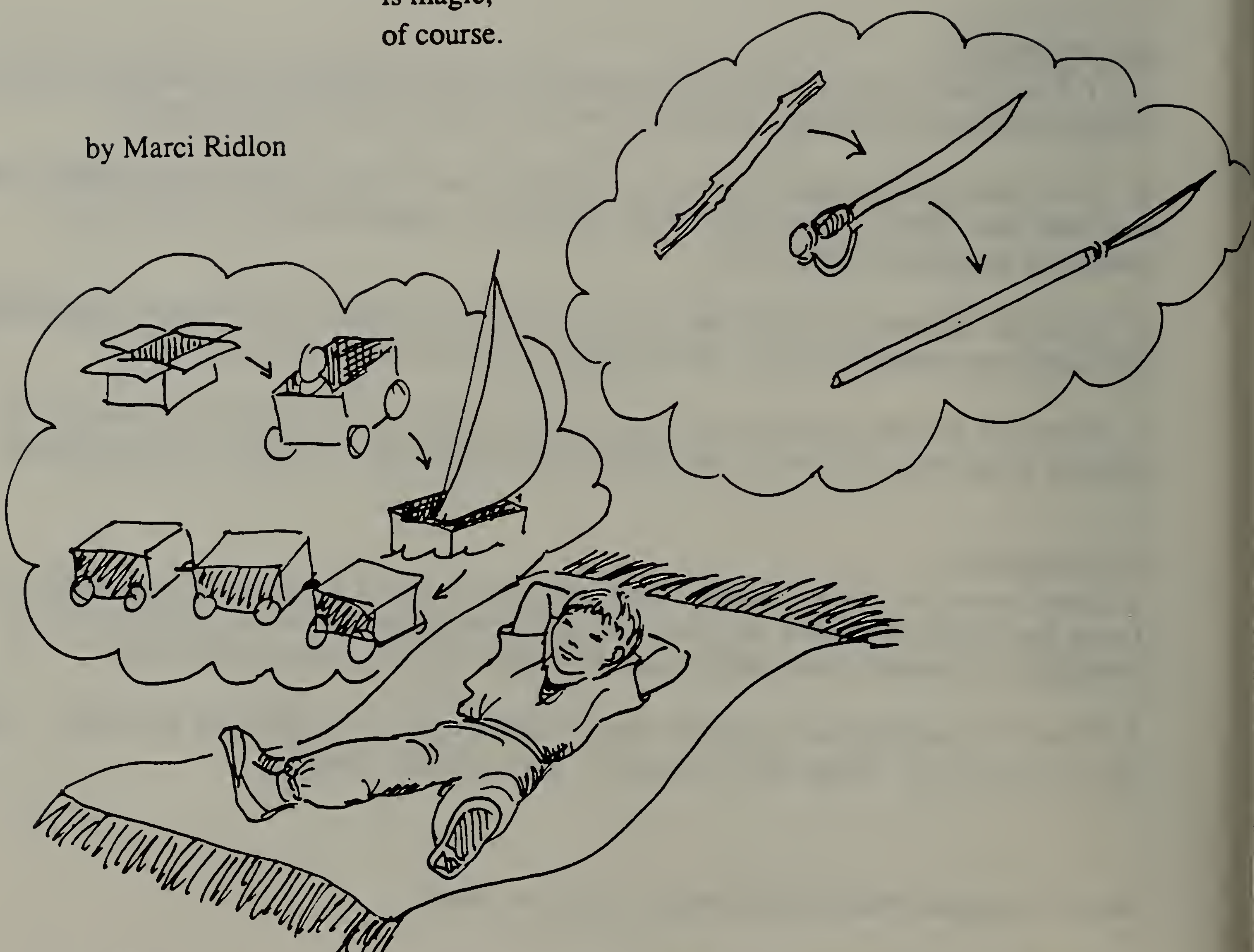
2. Have the students write a short story or poem about the item they just made. Where did it come from? What did it become? Is it trash or treasure?

Source: Adapted from AVR *Teacher's Resource Guide*

JOHNNY

To Johnny a box
is a house
or a car
or a ship
or a train
or a horse.
A stick
is a sword
or a spear
or a cane,
and a magic carpet
is magic,
of course.

by Marci Ridlon



EGG CARTONS AND THE ENVIRONMENT....

THEME:	Packaging affects the environment
GOAL:	Students will learn that some types of trash are more harmful to the environment than others, and that their actions as consumers can make a difference
METHOD:	Comparing styrofoam and cardboard egg cartons
SUBJECTS:	Art, Science
SKILLS:	Analyzing, comparing, creating
MATERIALS:	Cardboard and styrofoam egg cartons (have students bring samples from home); paper; glue; ribbons and various other craft materials
TIME:	One hour

BACKGROUND

Styrofoam is a trade name for polystyrene, a plastic which makes up approximately 12 percent of all plastic packaging. Polystyrene is used to make fast food containers, disposable cups, and egg cartons. Paper products such as cardboard egg cartons can be turned into pulp and recycled to make new egg containers and other paper goods. Recycling styrofoam is more limited. Federal regulations prevent most recycled plastic from being used for packaging food since it must be free of contaminants and the temperatures reached during the recycling process do not ensure sterilization. New recycling ventures for polystyrene include rubber home and office products, plastic lumber, park benches, marine docks, parking curbs, building insulation, flower pots, childrens' toys, and packing material. Styrofoam used to be made with chlorofluorocarbons (CFCs), which damage the ozone layer of the atmosphere. Manufacturers voluntarily eliminated CFCs from styrofoam production in 1988.

Fossil fuels used in the production of plastic are a non-renewable resource. Converting petroleum into a material that is generally used only once wastes valuable resources and adds to the growing solid waste stream. Recycling plastics is, therefore, as important as recycling glass, metal, and paper. The widespread recycling of styrofoam and other plastics will be encouraged as the market for it improves and as more cities, towns, and businesses develop programs for separating and collecting different types of plastics.

GETTING STARTED

What is the purpose of packaging? Name some different types of packaging. How does packaging affect the environment?

PROCEDURE

1. Divide the children into small groups and have them examine the egg cartons that they brought in. What are the differences and similarities? Discuss the differences that are not immediately noticeable (e.g., one is biodegradable and the other is not, one is recyclable and the other is not, one is made from renewable resources and the other is not, etc.).

2. Discuss with the students what happens to each of the cartons when they are thrown away. Do they both decompose at the same rate? Which type of egg container is best to use? With older students bring up the effects of styrofoam production on the ozone layer.

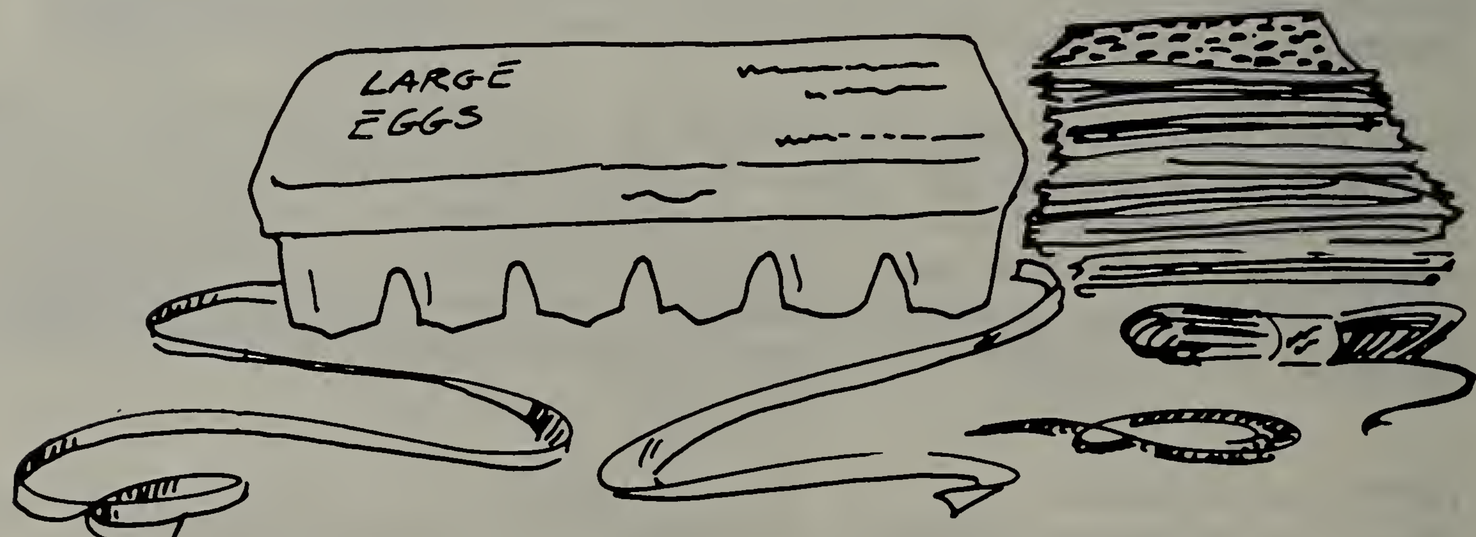
3. Brainstorm different ways to reuse the egg cartons by making button or paperclip holders, jewelry boxes, ornaments, etc.

EXTENSIONS

1. Start a classroom garden using the egg cartons as a nursery for starting plant seedlings.

2. Have the students make a list of packaging materials which they think are harmful to the environment. What other choices could they make instead (e.g., using popcorn instead of styrofoam noodles for padding packages)?

Source: Adapted from AVR *Teacher's Resource Guide*



GIVING TREES A SECOND CHANCE

THEME:	Recycling is one way to keep from wasting natural resources
GOAL:	Students will understand how both trees and recycled paper can be used to manufacture paper and other products
METHOD:	Puppet show or teacher demonstration
SUBJECTS:	Performing Arts, Science
SKILLS:	Observing, listening, problem solving, reasoning
MATERIALS:	Animal puppet; human puppet; small tub about 2ft x 1ft x 1ft, labelled paper factory; bowl; egg beater; paper; crayons; examples of non-recyclable "paper" items (e.g., envelopes with plastic windows, wax paper, foil-coated gum wrappers, etc.); examples of items made of recycled paper (e.g., cardboard egg cartons, ticket stubs, toilet paper rolls, etc.); cardboard tree; saw; rolling pin; small pitcher
TIME:	45 minutes

GETTING STARTED

Ask the children to name different types of paper products and list them on the board. What is paper made from?

PROCEDURE

1. Explain to the class that new paper products are generally made from trees, but that in some cases paper manufacturers can use recycled paper instead of new wood to produce paper items. Although trees will continue to be harvested, the number of trees that are cut can be reduced if recycling paper programs are instituted.

2. Set up stage on a front desk, along with the cardboard tree.

3. Introduce puppets, Rebecca Rabbit and the Logger, and tell the children they have a story to share with them. If possible, have two different adults act out the two parts.

(Play Begins)

Rebecca: Hi! My name is Rebecca Rabbit. I live here in the forest. Well, it's my nap time, good night.

(Rabbit lies down under cardboard tree. Human puppet with saw enters and starts to cut down the tree. You make saw noises.)

Rebecca: Hey! Hey! What are you doing?

Logger: I've got to cut down this tree so they can make newspaper. (Turns to students) Does anyone here have newspapers at their house? (Turns to Rabbit) To put out the paper every day, I have to cut down trees and haul them away.

Rebecca: But you can't do that! A lot of animals need this tree! I use its leaves in my burrow to make it warm. (Turns to students) Do you know any other animals that might use this tree?

(You will find out what they know and can add to it as needed. Examples include: birds, bugs, and squirrels live in them; beavers build their homes from them and eat the bark; many animals eat their fruit; animals use them to escape from predators, etc.)

Rebecca: (Turns to Logger) See all the things we need this tree for? How can you take it?!

Logger: People want to read the newspaper every day, as well as books and magazines, so I cut down trees and haul them away. (Logger drags tree off desk)

Rebecca: I'm going to follow him. I want to see where he's taking my tree! (Put tub upside down on desk) I think he brought it here. (Rebecca sticks her head into box and comes out again) Yes--here it is. (Turns to students) Can you see inside the factory? (Students say NO) Okay, I'll go inside and then tell you what is going on.

(Rebecca goes into box, which rattles and makes factory noises, then comes out).

Rebecca: It sure is loud in there! (Goes back in and comes out.) Now I can tell you how they make paper. First, they chop the tree into tiny pieces and put it in a huge bowl like this--(pretends to put sawdust into bowl)--except that their bowl is as big as this rug (or mention some other object that is about 8-foot square). Next, they pour water into it and stir it up just like this. (Rebecca pretends to pour in water from the pitcher and then uses eggbeater vigorously.)

Boy, am I tired! This takes a lot of energy! (Continues to use eggbeater.) I'm working hard. I'm using up a lot of my energy...Whew! Guess what it looks like now. It looks like hot cereal--Cream of Wheat! Have any of you ever eaten Cream of Wheat?

Now, is the paper you write on wet or dry? Dry? Well, the way they get the water out of this paper soup is with many huge rolling pins. I'm not kidding! They're as long as this room! Guess how many? Over one hundred huge rolling pins! (Put bowl on floor and demonstrate rolling pin on table.)

When they're done, the paper looks like this! (Hold up a piece of paper.) I think I'll draw a picture. (Rebecca scribbles) I don't like this one, I think I'll throw it away. (Heads for trash can.) Wait a minute. I can't throw this away! This was my tree. It took all that hard work to make this paper. What can I do?

(If children mention recycling, ask them what that means. If they don't, Rebecca can ask them if they've ever heard the word recycling. Students may also mention ways to reuse the paper.)

Recycling means you take the used paper back to the factory and make new paper out of it. I think I'll go back to the factory and see how this is done. (Rebecca sticks her head under the box and pulls it out again) It's almost the same as when they make new paper, but they don't have to cut down any trees. They use the old paper instead. (Rebecca shreds the paper into the bowl and uses the eggbeater on it, then pulls out another piece of paper, as good as new.)

The people at the factory told me to tell you to make sure you don't recycle kleenex. And gum wrappers cannot be recycled because they clog up the beaters. No plastic or wax paper either, okay? These things get caught in the drain and could ruin the new paper.

Can you guess what else they were making out of old paper? (Pull out and label whatever examples you have.) Pretty neat, huh? Do you kids have a box in your classroom to collect used paper that can be sent back to be recycled? That's great, you're saving trees from being cut down. (OR, We'll have to get you one so you can save trees from being cut down.) Just remember, no food or tissues in there.

Do you have any questions for me before I go? You know what? After today, I think I'm going to change my name. I think I'm going to call myself RECYCLING RABBIT! Well, it's time to go. Bye!

(The children may want some personal contact with Rebecca after the show, so you may want to have her kiss or shake the hands of the students before she leaves.)

THE END

EXTENSIONS

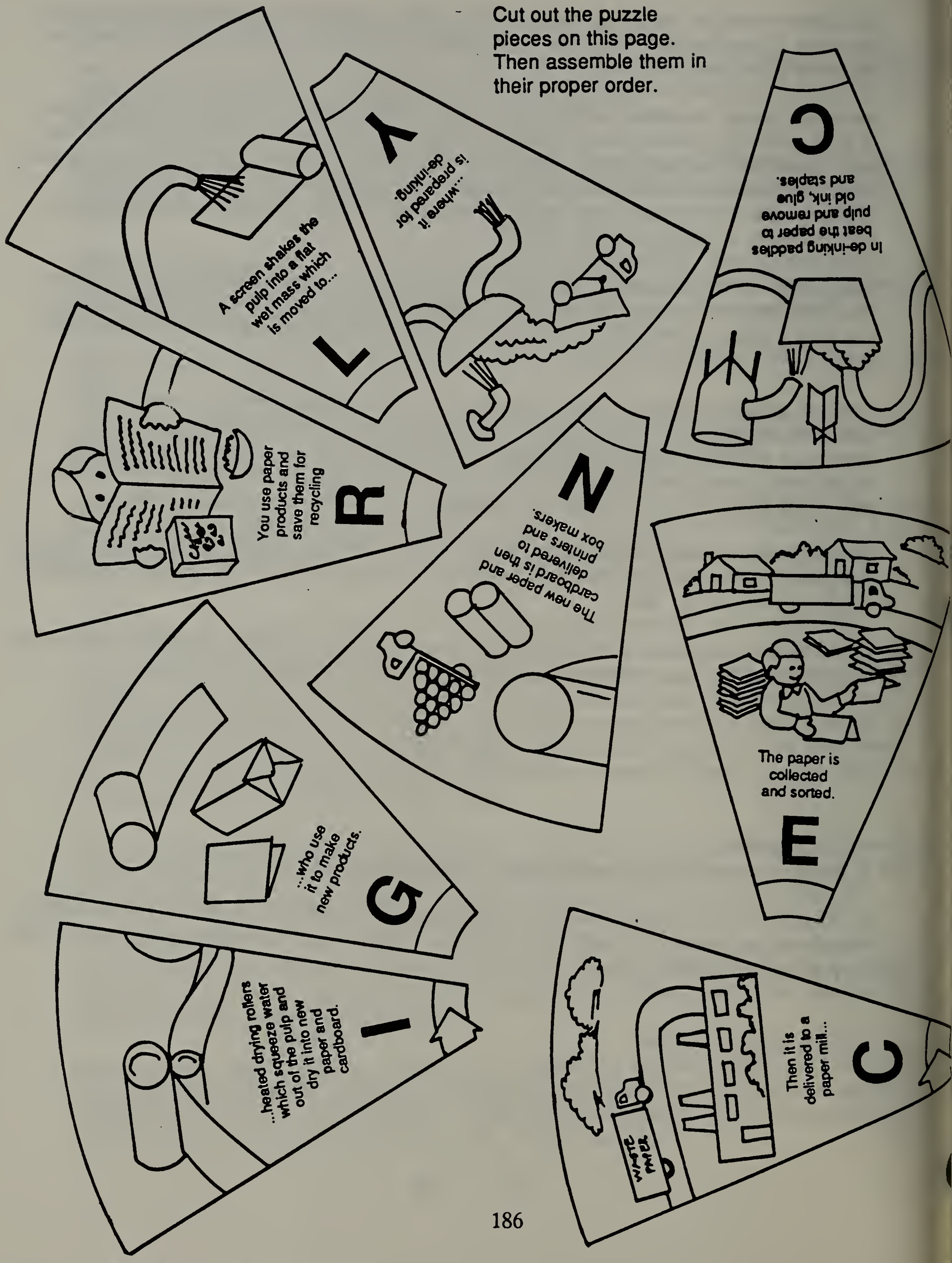
1. Have students make recycled paper. See PAPERMAKING activity.

2. Distribute the attached handout, "How Paper is Recycled." Have the children color the pieces and assemble them in their proper order. Make an enlargement of the pieces to post on the bulletin board.

Source: Kristen Walser

How Paper is Recyled

Cut out the puzzle pieces on this page. Then assemble them in their proper order.



Source: Reprinted with permission from *Oscar's Options*

JOIN THE RECYCLING TEAM

THEME:	Recycling is a positive action everyone can take
GOAL:	Students will understand that recycling is a team effort in which everyone can participate
METHOD:	Reading and discussion
SUBJECTS:	Language Arts, Performing Arts
SKILLS:	Listening
MATERIALS:	*The Little Red Hen*
TIME:	30 minutes

GETTING STARTED

Ask the students how many people are needed to recycle? Is it easier to recycle when people help one another?

PROCEDURE

1. Adapt the story of *The Little Red Hen* by changing the words. The story follows the original until the section where the hen finds the grains of wheat. Adapt the story to read:

One day when she was hoeing, she found some soda cans. Who will help me put these soda cans in the recycling bin?"

"Not I," said the cat. "Not I," said the dog. "Not I," said the duck. "Then I will," said the hen, and she did.

Each morning when she was cleaning around the house, she saved up all the glass bottles, metal cans, newspapers, and cardboard and put them aside. She stacked the paper and cardboard together and put the glass and cans in a large bin.

When the paper stacks became too high to reach, the Little Red Hen asked, "Who will help me put the newspapers and cardboard in bundles?"

"Not I," said the cat. "Not I," said the dog. "Not I," said the duck. "Then I will," said the hen, and she did.

When the glass and metal bin was full and there were several bundles of paper and cardboard the Little Red Hen said, "Who will help me take the bin and bundles to the recycling center?"

"Not I," said the cat. "Not I," said the dog. "Not I," said the duck. "Then I will," said the hen, and she did.

So the Little Red Hen piled everything in her car and drove to the recycling center where she put everything in its place. With the money she got for the bottles, she bought a fresh loaf of bread.

The rest of the story can continue until the end, when all the animals help her collect, bundle, and deliver the recyclables to the center.

2. Have the children act out the story as a play.

Source: Kristen Walser

PAPERMAKING

THEME:	Some products can be recycled into new and useful items
GOAL:	Students will learn how paper is recycled
METHOD:	Making recycled paper
SUBJECTS:	Art, Science
SKILLS:	Designing, experimenting, observing, predicting
MATERIALS:	Scrap paper (white ledger paper, construction paper, etc.); decorative filler scraps (flowers, seeds, pine needles, yarn, thread, feathers, etc.); two wooden frames of the same size; nylon fly screening or the equivalent; duct tape; staple gun; tin cans; absorbent rags or towels as large as the frames; one 24" x 16" plastic wash basin; blender; sponge
TIME:	Two hours

BACKGROUND

Paper makes up 41 percent by weight of all household trash; at least one-quarter of this is newspaper which is discarded after only one day of use. Although wood is a renewable resource, our wasteful habits are using up forest resources faster than they are being replaced. Recycling paper can help conserve the energy and natural resources that are used to make paper.

Almost all paper is recyclable and most of the paper we use daily contains recycled fiber. People are the link in the paper recycling process. If more people recycled paper fewer trees would need to be harvested and less waste material would need to be burned or buried.

GETTING STARTED

Ask the students why we should recycle paper?

PROCEDURE

<u>NOTE</u>: Making paper can be a messy proposition because of the amount of water that is drained and pressed out of the material. Keep handy absorbent material such as sponges, sheets, or towels. Avoid using newspaper to soak up excess water; newsprint will turn everything grey.

Set up stations around the room to allow everyone in the class to participate at the same time. Each station should be equipped with one basin and mould and deckle for each four to five students.

1. Introduce the process of papermaking to the class. (NOTE: See explanation in background text, pages 5-6, and 159).

2. Have the students make their own paper, following the directions on the attached sheet. Explain to the class that the machines used in the manufacture of recycled paper perform all the same tasks they will perform in this experiment. When they are through, compare the students' recycled paper with other types of paper in the classroom and to commercially manufactured recycled paper. How do they differ in weight, color, texture, durability, and as a surface for writing?

3. Start a discussion about the reasons for recycling (e.g., conserving trees, energy, landfill space, etc.). Also introduce the related problems of water pollution, contaminants, and paper grades.

EXTENSIONS

1. Have children write short poems (e.g., Haiku) or stories about trees on their recycled paper. (NOTE: Test pens first to make sure they do not bleed.)

2. Have the class weigh all the waste paper it generates in a week. Have the students separate out the recyclable portion and weigh the remainder to see how much the class would save by recycling. Start a contest with another class or for the entire school to see who can recycle the most.

Sources: Adapted from AVR *Teacher's Resource Guide*; *Oscar's Options*

PAPERMAKING

1. Before making paper, construct a "paper mould" by building a wooden frame (suggested size 6" x 9") and stapling nylon fly screening to it. To help make the paper more even, assemble a second wooden frame (also 6" x 9"), called a "deckle," without the fly screening. If you cannot construct frames, cut out a piece of screening 6" x 9" and cover all the rough edges with duct tape.

2. Start by having students tear scrap paper into tiny pieces. Soak them in a dishpan of hot water for 30 minutes.

3. Fill the blender half-full of warm water and place a handful of soaked paper into it. (WARNING: too much paper will burn out the motor.) Mix at medium speed until it has a watery-creamy consistency. This means the paper fibers have broken down and are now considered pulp. Repeat with successive batches of soaked paper scraps.

4. OPTIONAL: To make colored paper, add food coloring, non-toxic fabric dye, or bits of grass, dried flowers, or orange peels directly to the pulp in the blender or to the mixture in Step #5.

5. Fill a dishpan with 4 to 6 inches of water and pour in the paper "slurry" from the blender. Mix by hand. The amount of pulp you add to the water in the basin will affect the thickness of the paper. (NOTE: For younger students, a thicker slurry and paper will ensure greater success.)

6. Put the deckle on top of the mould with screen. Using two hands, dip the mould into the dishpan, lifting up some of the pulp onto the screen, or use a tin can to pour liquid and pulp onto the screen. Gently rock the mould back and forth to get an even layer of fibers on the screen. Let water drain through the screen for several minutes. Put mould on a protected surface (plastic sheeting covered by a towel or rag) and carefully lift the deckle off the mould. In place on the screen is your newly formed piece of paper.

7. To remove the paper from the screen, lay a piece of light-colored construction paper on top of the newly formed piece of recycled paper and turn the screen over onto the towel on the table. From the back of the screen, sponge off any excess water. Gently lift off the screen and the recycled paper should remain on the piece of construction paper. Place another piece of construction paper on top of the recycled piece, to form a sandwich.

8. To dry the paper quickly, place this "sandwich" on a towel and iron it at a medium setting. Once dry, gently remove the new recycled paper from the two pieces of construction paper. It can also be dried by pressing it onto a pane of glass such as window or setting it aside in a warm place for one to two hours.

9. CLEAN-UP: Pour the leftover pulp in a strainer. DO NOT pour pulp down the drain because it might block it. The strained pulp can be discarded or kept in a plastic bag in the freezer for the next papermaking exercise.

REUSE OR RECYCLE

THEME:	Many items we throw away can be reused or recycled
GOAL:	Students will discover how and where they could recycle or reuse items they typically throw away
METHOD:	Completing checklist and discussion
SUBJECTS:	Language Arts, Social Studies, Science
SKILLS:	Interpreting, predicting
MATERIALS:	"Reuse or Recycle: Discarded Materials Checklist"
TIME:	One hour

GETTING STARTED

Can the items you throw away be used again?

PROCEDURE

1. Explain to the class the concepts of recycling (and composting), showing them examples of recycled products. Give each student a copy of the "Reuse or Recycle" checklist to fill out over the next week. Alternatively, post the checklist on the board and have the class work through it as a group.

2. Have each student make a tally of the results of his or her checklist. Make a class summary on the board and use it to have the students answer the discussion questions on the checklist.

EXTENSIONS

1. Have the students brainstorm the steps they might take to design and implement a recycling project for the class or for the entire school. (See "How to Start A School Recycling Program," page 163-164.)

2. List recyclables on the board. Discuss what happens to the items when they are recycled. Can these items be recycled locally?

Source: Adapted from Wisconsin *Recycling Study Guide*

REUSE OR RECYCLE
DISCARDED MATERIALS CHECKLIST

Put an **X** next to items you threw away in the wastebasket this week and then **circle** the items you think could have been recycled or reused.

___ orange peel

___ broken toy

___ plastic bag

___ grass clippings

___ plastic milk carton

___ glass jar

___ other

___ paper bag

___ book

___ paper milk carton

___ napkin

___ apple core

___ tin can

___ newspaper

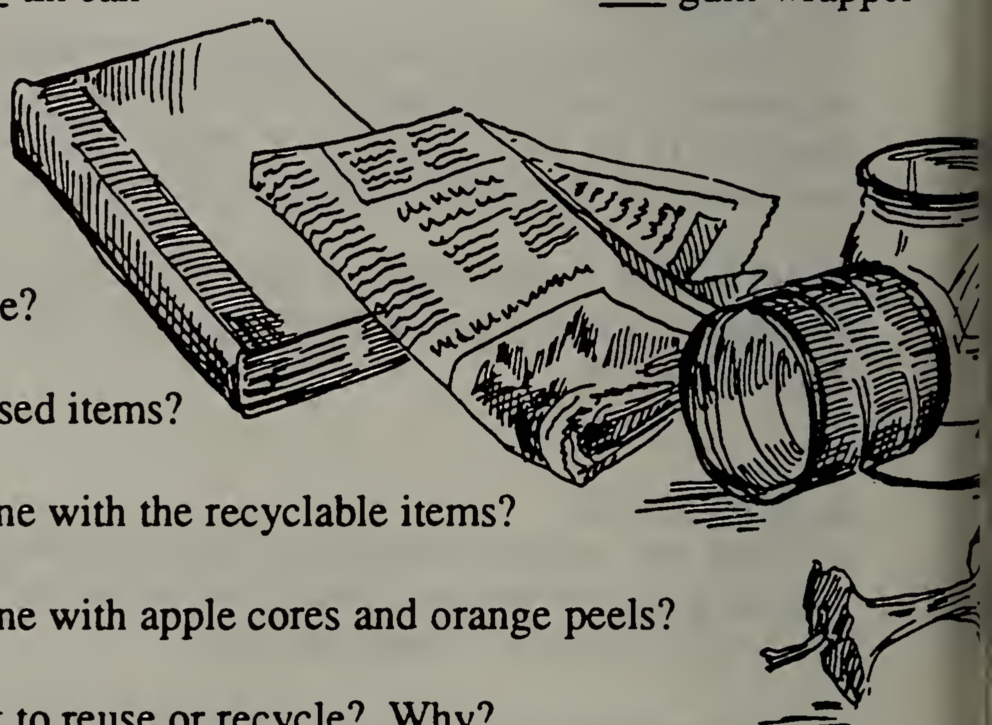
___ magazine

___ other paper

___ aluminum can

___ old clothes

___ gum wrapper



Discussion Questions

1. What items did you circle?
2. How could you have reused items?
3. What could you have done with the recyclable items?
4. What could you have done with apple cores and orange peels?
5. Which items are difficult to reuse or recycle? Why?
6. Should we as a society be making items that are not reusable or recyclable?
7. Should items that are wrapped in difficult-to-dispose-of packaging cost more?
8. Did any of your classmates reuse or recycle any item you circled? How did they reuse or recycle them? Was reusing or recycling them easy or difficult?
9. What do you think happens to the items you didn't circle?

NATURE AT WORK

THEME:	Organic waste can be recycled (composted) and used to enrich soil
GOAL:	Students will learn about recycling organic wastes
METHOD:	Building a model compost pile
SUBJECTS:	Science
SKILLS:	Classifying, inferring, observing, predicting
MATERIALS:	Aquarium; organic wastes: soil (NOT potting soil); thermometer; trowel or large spoon; one to two dozen red earthworms
TIME:	One hour to assemble, up to one year for observation

BACKGROUND

Composting is the oldest form of recycling. It is based on the scientific principle that nothing ever really dies, but just changes shape and takes on new forms. When a leaf falls and begins to decompose, it is broken down by time, weather, insects, and worms into the original materials from which it was made. The same is true for waste we throw away everyday such as grass clippings, banana peels, egg shells and apple cores. These materials can be set aside to be used as fertilizers in gardens and farms.

Compost is formed through the action of certain microbes that proliferate when mixed organic refuse receives sufficient air and water. These bacteria, which generate a temperature of 150 degrees, literally cook the wastes. The finished product called compost or humus, is an excellent fertilizer and looks just like soil. It is high in carbon and nitrogen, which are important sources of food for plants and vegetables. In addition to being clean, safe, and thrifty, composting can significantly reduce the volume of solid waste generated by a household.

....Oscar's Options

GETTING STARTED

Can food scraps, leaves, and grass clippings be recycled?

PROCEDURE

1. Have the students bring in a variety of organic wastes such as green grass clippings, sawdust, wood ash, leaves, kitchen food scraps, etc. (Avoid meat scraps, dairy products, fats, and oils which inhibit decomposition, cause odors, and can attract pests.) Tear or chop the materials into small pieces, leaving a few larger pieces of each type of waste for comparing rates of decomposition. Ask the students if they think there will be a difference.

2. As a class, alternate layers of the materials in the aquarium as follows (amounts are approximate): one inch of soil, two inches of dry, carbon rich, organic waste (i.e., leaves), one inch of green grass clippings, and sprinkle of water. Repeat several times.

3. Cover the last layer with one-half inch of soil and water the pile so it is moist, but not soggy--like a damp sponge.

4. Have the students add the earthworms and observe their behavior.

5. Place the compost pile where it will be at room temperature (but not in direct sunlight). Once a week have a student test the temperature of the pile--for consistency, take temperature at the same location, depth, and time each week--and vigorously mix the pile to aerate it. Make a temperature graph and have the student enter his or her reading.

6. As the class starts to see changes in the pile, discuss the process of composting. How does it reduce the amount of waste thrown out? What happens to organic wastes that end up in the landfill? Is the landfill a gigantic natural compost pile, or are there problems with placing large amounts of organic material in landfills?

EXTENSIONS

1. Have the children write and illustrate a story which explains what they have learned about composting. Where applicable, encourage them to construct a compost pile at home to use on the family garden or flower beds.

2. Have the class begin a school garden or "adopt" a particular flower bed. Have them add the compost they made and plant some flowers or vegetables.

Source: Adapted from Wisconsin *Recycling Study Guide*

THE BURNING QUESTION

THEME:	Combustion as a waste management method has both benefits and drawbacks
GOAL:	Students will evaluate the advantages and disadvantages of combustion
METHOD:	Visiting a waste combustion facility
SUBJECTS:	English, Science, Social Studies
SKILLS:	Comparing, observing, value judgement
MATERIALS:	None
TIME:	One class period, plus additional time for field trip

GETTING STARTED

Is burning a good way to get rid of trash?

PROCEDURE

1. Introduce the process of incineration and its advantages and drawbacks as a waste management tool. Note that burning can reduce the volume of trash by 80 to 90 percent. The concepts of volume and weight reduction might be addressed through comparison with a wood fire and the amount of material visible before it is ignited vs. what remains after the fire has burned out.

2. Invite the manager of an incinerator to class to describe how the process works, what sort of preparation is needed, what kind of special treatment is required for the ash residue, etc.

3. Arrange a trip to visit a waste combustion facility. A list of facilities can be obtained from DEP's Division of Solid Waste Management. Have the students prepare questions prior to the trip. One option would be to divide students into small groups with each assigned a different angle such as the physical process involved, air emissions, ash residues, siting issues, etc. Each group would be responsible for getting information on their topic and presenting the results to the class.

4. Construct a wall chart comparing the advantages and disadvantages of combustion.

EXTENSIONS

1. Take a sample of trash and have the students sort out items that could be reused or recycled, removing them from the waste stream. Compare the amount left to be burned to the original sample. Discuss the implications of burning versus recycling.

2. If your community is serviced by an incinerator, have the students research how much of the town's solid waste is burned, as compared to recycled. Have the class determine the economics of incineration vs. recycling and prepare a report on their findings.

Source: Adapted from AVR *Teacher's Resource Guide*

BUILD A MINI-LANDFILL

THEME:	Landfilling is one method for disposing of solid waste in Massachusetts
GOAL:	Students will understand the process of decomposition in landfills
METHOD:	Constructing a small-scale replica of a landfill
SUBJECTS:	Science
SKILLS:	Observing, recording
MATERIALS:	Two identical samples of food scraps, newspaper, cardboard, glass, cloth, aluminum foil, plastics, copper wire, etc.; a cardboard shoe box or small aquarium; plastic bags to line the box or tank; soil (NOT potting soil); masking tape; index cards or small cardboard squares; water; magnifying glass; "Mini-Landfill" worksheet
TIME:	One hour the first day, 10 to 15 minutes each day thereafter for three weeks

GETTING STARTED

What kinds of materials will break down into their natural elements (biodegrade) in a landfill? What kinds of materials will not?

PROCEDURE

1. Explain to the students the purpose of a landfill and how they are constructed. Note that landfills not only hold waste, but that the process of covering garbage with soil actually helps to break it down into smaller pieces and simpler components.

2. Have the students, individually or in small groups, construct their own mini-landfill. Line a shoe box or aquarium with a plastic bag and fill it half full of earth. (**NOTE: Do not use potting soil**--it has been sterilized and does not contain the microorganisms which are essential to the process!)

3. Have each student or group bury two identical rows of trash, marking the location of each item with a cardboard label.

4. On the worksheet, each student or group should note the items placed in the landfill, along with the date. Have them add water to moisten the soil and place the mini-landfill in a sunny spot. The landfills should be watered regularly, keeping the soil moist but not wet, to simulate rain.

5. After seven to ten days, have the students carefully remove the waste items from one row of the landfill and examine them. (A magnifying glass may be helpful at this point.) Students should complete the questions for Week One on the "Mini-Landfill" worksheet.

6. Wait another seven to ten days and repeat the procedure for the second row of buried materials. Have the students complete the questions for Week Two on the worksheet.

7. Use the students' observations to discuss the results, addressing questions such as: Which items in the landfill decomposed the most? Were the decomposed items natural or manmade? What characteristics are shared by the items which decomposed the quickest? Some items showed no signs of decomposition: Will they remain unchanged for a long time and why? If the landfill had been made of sterilized soil, would the waste have decomposed as quickly?

EXTENSIONS

1. Have students replace the items removed in step 6 and cover the box or aquarium. Let it sit for at least two months to allow for leachate formation. (Leachate will collect in the bottom of the plastic bag.) Have students empty the contents of the landfill to determine which items decomposed and which did not. Also have them collect a sample of the leachate and test its acidity.

2. Have the students research why leachate needs to be controlled at landfills, addressing what kinds of materials are commonly found in leachate and whether or not they are harmful.

3. Items such as disposal diapers and plastic trash bags are being advertised as biodegradable. Discuss with the class the meaning of biodegradable and whether these products are indeed biodegradable and why.

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MINI LANDFILL WORKSHEET

1. List the items placed in the landfill and the date you buried them

____

____

2. The items which decomposed the most are:

Week 1. ______________________________

____

Week 2. ______________________________

____

3. The following items decomposed a little:

Week 1. ______________________________

____

Week 2. ______________________________

____

4. These did not change at all:

Week 1. ______________________________

____

Week 2. ______________________________

____

MINI LANDFILL WORKSHEET (cont.)

5. Why do you think some items are decomposing more quickly than others?

____

____

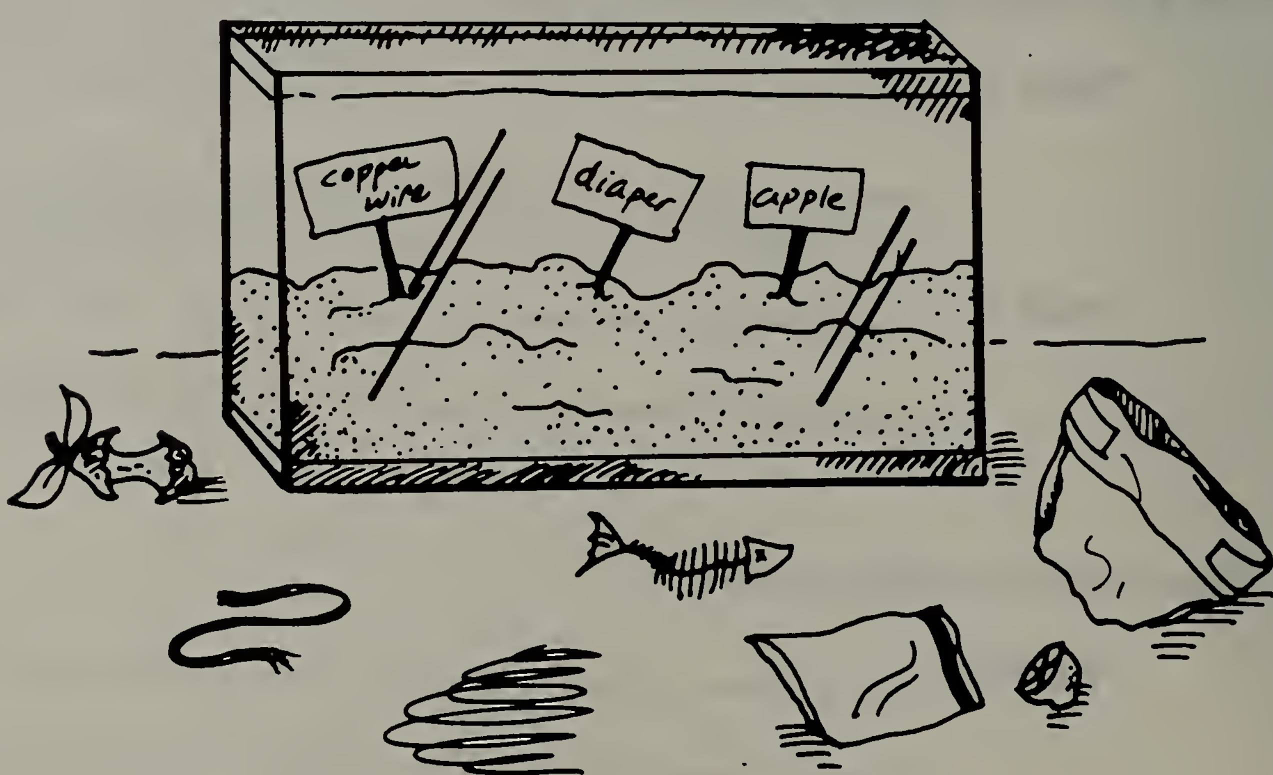
____

6. Note any significant changes which have occurred between observations?

____

____

____



WASTE DISPOSAL AT SCHOOL: WHERE DOES IT GO?

THEME:	There are limited options for the disposal of trash
GOAL:	Students will understand where the trash from their school or community is taken, and what is involved in this process
METHOD:	Interviewing school custodian or trash hauler
SUBJECTS:	Art, Language Arts, Science, Social Studies
SKILLS:	Experimenting, interviewing
MATERIALS:	Tape recorder, video camera (optional), a few samples of trash
TIME:	Two 15 to 30 minute periods

GETTING STARTED

Ask the students where their trash goes after being collected from school.

PROCEDURE

1. Invite the school custodian to the class and have the students interview him/her about trash removal. Have the class write down questions they would like to ask prior to the interview. These might include:

   a. How often is the trash collected?
   b. How long does it take?
   c. Where is it taken? Where does it go from there? What happens to the trash?
   d. Is it ever used again for anything?
   e. What is most of the trash composed of?
   f. How much trash do we throw out each week?
   g. What does it cost to throw it out?

2. After the interview, have the students draw pictures which reflect the information they just learned. Ask them to write an accompanying paragraph, further describing the interview and post these as a bulletin board display. Send copies to the custodian as a thank you note.

EXTENSIONS

1. Arrange for students to meet the school's trash hauler when he or she comes to pick up the trash. When the truck comes, have children watch the trash removal process and ask the following questions:

a. When do you start working in the morning and when do you finish at night?
b. How many truckloads of trash do you collect each day?
c. Why is your truck designed the way it is and how does it work?
d. How many houses and businesses do you collect from?
e. How many miles do you drive each day?
f. Where do you take the trash?
g. What happens to it then?
h. Is it ever used again?
i. How long have you had your job? Have you noticed any changes in the amount or composition of trash since you started?

2. Take the class on a field trip to a landfill or combustion facility. A list of facilities can be obtained from DEP's Division of Solid Waste Management. Discuss the process, benefits, and potential problems associated with each method of disposal. For example, if the town sends its trash to a combustion facility, discuss whether or not all the trash disappears. If you visit a landfill, find out if it is running out of space. If so, what will the community then do with its trash?

3. Have the students create a mural about how trash is created, collected, and disposed.

Source: Adapted from AVR *Teacher's Resource Guide*

TV TECHNIQUES: ADVERTISING FOR THE ENVIRONMENT

THEME:	Advertisers often overlook the environmental consequences of their product and its packaging
GOAL:	Students will learn that commercials can be promotional and still consider the product's impact on the environment
METHOD:	Revising television or radio ads
SUBJECTS:	English, Science, Social Studies
SKILLS:	Analyzing, communicating, designing
MATERIALS:	A video camera to tape commercials (optional)
TIME:	Several class periods

BACKGROUND

Television and radio ads persuade us to purchase certain items for reasons other than product quality. Many of these products, although useful and desirable, can have far-reaching environmental impacts which are not normally considered by advertisers or purchasers.

GETTING STARTED

What sorts of techniques do advertisers use to sell their products? How effective are these techniques? Do certain commercials target specific audiences?

PROCEDURE

1. In preparation for making their own TV commercials, have students view one hour of TV, paying special attention to the content and duration of the ads. Ask them to list the various methods advertisers use in commercials (e.g., sex appeal, convenience, status symbol, flashy packaging, famous people). Assign each student a particular time to watch or listen to commercials. This will enable them to decide whether advertisers use specific techniques to reach particular audiences.

2. As a class, discuss the results. What techniques are used most often? Was product durability or effect on the environment ever mentioned? Are advertisers concerned with overpackaging or reducing the amount of waste generated by their product?

3. Have each student select a commercial to revise. The new commercial should present the environmental consequences of making and using the product and should appeal to the consumer. Students may want to create a new package or alter the item to make it less wasteful. For example, an ad for soda could promote the fact that it uses reusable glass bottles instead of plastic and that the energy used to produce the containers was derived from burning trash rather than fossil fuels.

4. Have the students present their new commercials in front of the class and discuss why and how they changed the original ad. Encourage students to give each other feedback on the effectiveness of the new commercial.

EXTENSIONS

1. Have students write to the manufacturer of the product and explain how and why they changed the ad for their product.

Source: Adapted from *A-Way with Waste*

BACK TO BASICS

THEME:	The production and disposal of packaging affects our natural environment
GOAL:	Students will explore the natural resources used to create different types of packaging
METHOD:	Researching the manufacture and disposal of different types of packaging
SUBJECTS:	English, Science, Social Studies
SKILLS:	Analyzing, drawing conclusions, reporting, researching
MATERIALS:	None
TIME:	Several class periods

GETTING STARTED

Begin a discussion by asking the students to list different types of packaging materials. What raw materials are used to make these? How do they become the package that we buy at the store?

PROCEDURE

1. Divide the class into the following groups, with each one representing a type of packaging: 1) aluminum can; 2) egg carton; 3) plastic bags; 4) cardboard box; 5) soda bottle; 6) tin can; and 7) milk container.

2. Have each group research their packaging type, tracing its creation from raw materials through to the final product. The students might also explore the cultural or historical basis for using this material for packaging and what was used in earlier generations. Each team should prepare an illustrated report to distribute to the rest of the class.

3. Select a representative from each group to present their report to the class. Discuss the advantages and disadvantages of each type of packaging. Which ones use the most energy and resources to manufacture? for disposal? Which one uses the least? Which types of packaging have the greatest environmental impacts? What could we do to help minimize these negative impacts?

EXTENSIONS

1. Have the students write letters to product manufacturers with the results of their research and their suggestions as to what would be a better package for the product.

Source: Adapted from AVR *Teacher's Resource Guide*

A PICTURE IS WORTH A THOUSAND WORDS

THEME:	Art reflects the values of society
GOAL:	Students will appreciate the ability to influence society through artistic media
METHOD:	Creating artistic works (pictures, poems or short stories, photographs, songs, paintings, etc.)
SUBJECTS:	Art, English, Social Studies
SKILLS:	Analyzing, creating, value judgement
MATERIALS:	Examples of artwork; craft supplies (paint, markers, glue, etc.)
TIME:	One to two hours

BACKGROUND

Art often reflects what society values. Sometimes artistic expression can impact society by making it see its own flaws, including wasteful habits at the cost of the environment.

GETTING STARTED

Ask the students to name their favorite form of art--music? painting? dance? poetry? photography? Have them consider: In what ways does art affect you? reflect you?

PROCEDURE

1. Provide or have students bring in samples of art that reflect an appreciation of the natural environment (e.g., the paintings of Thomas Cole), portray American values (e.g., selections from the essays of H.D. Thoreau), or illustrate our wasteful habits.

2. Have the class discuss the various examples, addressing questions such as: What message was the artist trying to get across? How did he or she achieve this? How does his or her art affect you?

3. Ask each student to create a piece of artwork that reflects how they personally would like to change our throw-away society.

4. Organize an informal show for the students to present their projects to the rest of the class. Have each explain why they choose the artistic medium they did. Let other students guess and then discuss the message behind each piece.

EXTENSIONS

1. Hold an exhibit of all art projects, either at the school or in a local building such as the town hall or library. Have students write a brief paragraph to accompany their work.

THE SMART SHOPPER

THEME:	Each of us is responsible for the size and content of the waste stream
GOAL:	Students will examine their own buying habits in terms of solid waste generation
METHOD:	Examining and evaluating products
SUBJECTS:	English, Home Economics, Social Studies
SKILLS:	Communicating, interpreting, recording
MATERIALS:	Construction paper; markers
TIME:	15 minutes to discuss assignment; one class period to discuss results

GETTING STARTED

Ask the students what factors influence what products they decide to buy? Do they think about what happens to the solid waste stream when they throw away those items?

PROCEDURE

1. Have students ask their families the following questions about their shopping habits.

a) Does the ability to recycle a product or its packaging play a part in determining what you buy?

b) When shopping, do you think of how easy or difficult the product or its packaging will be to dispose of?

c) Which factors influence your decision to buy a product:

___ cost per pound
___ convenience in preparation or use
___ advertising
___ high nutritional value
___ lack of artificial coloring or preservatives
___ trying something new
___ familiarity with the brand
___ other

2. Have the class discuss the results of the survey. What are some of the most common reasons for buying a product? How often was recyclability or packaging taken into account?

3. As a class, come up with shopping strategies that might help to reduce the waste stream (e.g., choosing paper bags over plastic, choosing foods that are not excessively packaged or over processed). Have students make a "Smart Shoppers Sheet" to hang on their refrigerators at home.

Sources: Adapted from AVR *Teacher's Resource Guide*; *A-Way with Waste*

PACKAGING DESIGN FAIR

THEME:	Packaging is useful and necessary, but also contributes to many of our solid waste problems
GOAL:	Students will explore the function of packaging and what makes packaging both effective and environmentally sound
METHOD:	Designing the "perfect" packaging
SUBJECTS:	Environmental Education, Home Economics, Social Studies
SKILLS:	Analyzing, designing
MATERIALS:	Drawing materials; commercially packaged products; magazines
TIME:	Two class periods

BACKGROUND

Packaging has a number of functions and benefits, as well as some drawbacks.

Merits of packaging include:

* preserves and protects the product
* provides instructions on product use
* advertises product and increases sales and profits
* ensures public health and safety

Drawbacks of packaging can include:

* contributes significantly to the waste stream
* often increases production costs
* create false impressions of the actual product
* contributes to our litter problem
* wastes natural resources and energy, especially when materials cannot be reused or recycled

GETTING STARTED

Why is it important to change the way that some of the things we buy are packaged? Could packaging be designed to be less wasteful and still accomplish the same functions?

PROCEDURE

1. Have the students look through magazines and cut out pictures of packaged products. (Students could also bring in a commercially packaged product they are interested in studying.) Each student should choose one product for which they will design an alternative package.

2. Ask the students to look at their product and decide what the designer was trying to accomplish. Discuss the functions and drawbacks of the packaging. What is the packaging made from? What materials were used? Are any of the products designed to protect the environment?

3. Have the students design a new environmentally-sound alternative to their packaging. The designs should include considerations of waste reduction, reuse, and recycling, as well as public safety, product protection, shipping weight, cost of packaging material, advertising, and public demand. New design parameters should include some or all of the following: minimum resource extraction, minimum use of energy in processing, minimum transportation, selection of reusable or recyclable resources, design for reusability and recyclability, use of non-hazardous materials, etc. How do these new parameters conflict with, or limit, the old packaging?

4. Have the students list the materials they used and explain their choices. Each student should present their new design and explain the functions and environmental impact of the new packaging.

5. Display the students' new packaging designs (or actual items, if applicable). Each item should be accompanied by a paragraph explaining the new design, its impacts, and why it is better than the old one.

EXTENSIONS

1. Invite representatives from organizations such as the Environmental Shoppers Campaign, the local landfill, a recycling facility, or a newspaper to come and view the displays and discuss their organization's efforts to address this issue.

Sources: Adapted from AVR *Teacher's Resource Guide*; *A-Way With Waste*

GRAPHING PRICES FOR RECYCLABLES

THEME:	The market for recycled materials changes over time
GOAL:	Students will see how fluctuating markets and different prices affect recycling
METHOD:	Researching and analyzing prices for recyclables
SUBJECTS:	Business, Math
SKILLS:	Analyzing, interpreting
MATERIALS:	Graph paper; transparencies; *Recyclable Material Markets* list (available from DEP's Division of Solid Waste Management)
TIME:	Several months

BACKGROUND

In order for recycling to be worthwhile, collected materials must be re-manufactured into desirable products and sold to consumers. This calls for industry to accept recycled goods in place of raw materials. A challenge that confronts recycling is the development of consistent end markets for materials separated from the waste stream.

GETTING STARTED

What prices are being paid for recyclable materials? What factors influence these prices? How often do they change?

PROCEDURE

1. Discuss the concept of recycling. Illustrate the process with several examples of the "life histories" of recyclable items, from their natural resource base to their original use to how they are recycled and used a second time, third time, etc.

2. Obtain DEP's list of "Recyclable Material Markets." Working in teams have the students interview several recyclers, gathering information such as: What recyclables do you collect? How much do you collect of each type? What price do you receive for each ton of material delivered to market? What factors influence the price you are paid for each item? Are there markets for other recyclables not now being collected? Have each team write up their interview in the format of a newspaper article.

3. Based on the figures obtained from different recyclers, have the students graph the information by:

a. amount of material
   -- glass (green, brown, clear, mixed);
   -- paper (newsprint, corrugated cardboard, white ledger, etc.)
   -- metal (steel and aluminum cans)
   -- plastic (HDPE, PET, etc.)

b. charge to collect recyclables

c. cost to process recyclables

d. price received when sold to manufacturers

Have the teams repeat this exercise for several months to examine price fluctuations. Which type of recyclables pay the most? Why might the prices vary from month to month?

EXTENSIONS

1. Have the teams research where the recycled items are picked up and where they are eventually taken. Compare the transportation costs with the value of the materials being recycled.

2. Have the students research the advantages and disadvantages of industry using recycled goods instead of raw materials. They should examine issues such as: For what types of goods does this work the best? Is it more or less expensive? Are these cost differences passed onto the consumer? Does industry have difficulties finding a consistent supply of recycled materials?

Source: Adapted from *A-Way With Waste*

MY TWENTY FOOT SWATH

THEME:	Every person contributes to solid waste problems and has a responsibility to help solve them
GOAL:	Students will develop a plan for decreasing pollution in the environment by setting realistic personal goals
METHOD:	Reading essay and developing a personal action plan
SUBJECTS:	English, Social Studies
SKILLS:	Brainstorming, problem solving, value judgement
MATERIALS:	*My Twenty Foot Swath* by Kenneth Lundberg
TIME:	One class period, plus several weeks to keep journal

GETTING STARTED

Ask the students whether personal or global problems such as poverty or environmental pollution ever become so overwhelming that they were immobilized or driven to some action that actually aggravated the problem? Discuss some examples.

PROCEDURE

1. Have the students read the essay, *My Twenty Foot Swath*. Each student should think of three questions or issues this piece raises, and write them on separate slips of paper. Pool the questions together in a box and have each student select one at random to answer, either in writing or orally in front of the class.

2. Have students relate similar personal experiences to the one described by Lundberg. As a class, brainstorm different ways to expand positive action from a personal level to the world community.

3. Have each student select a problem which makes them feel helpless, outline a positive action plan, and keep a daily journal documenting their experiences and feelings.

Sources: Adapted from AVR *Teacher's Resource Guide*; *A-Way With Waste*

MY TWENTY FOOT SWATH
By Kenneth V. Lundberg
Covenant Companion

"I worried so much about world hunger today, that I went home and ate five cookies." Did personal or global problems ever become so overwhelming that you were immobilized, or driven to some action that actually aggravated the problem? Have you experienced such frustration about the hopelessness of solving the problems of poverty, environmental pollution, or human suffering that you could avoid it only by deciding that your were powerless to do anything about their alleviation? This is called Responsibility Assumption Overload.
Here's how I dealt with this feeling. I park my car away from my building at work. That way I get both exercise and parking space, as everyone else competes for spots next to the entrance. My morning and late afternoon strolls take me on a stretch of lawn between the tennis courts and the soccer field, and across an occasionally used softball diamond.
The lawn is twenty feet wide, more or less. Soft and green, it was originally very littered. Tennis players discard tennis ball containers (and their flip tops), worn out sweat socks, broken shoelaces and old candy bar wrappers. Soccer game spectators leave behind beer bottles and junk food cellophane.

In my early days it disgusted me, and my thoughts centered on ways of correcting the situation writing letters to the campus newspaper (no doubt totally ignored): campaigning for anti-litter regulations (who would enforce them?): organizing a Zap-Day" cleanup (leaving 364 days of littering). All my noble efforts would have demonstrated my indignation, raised my blood pressure, and attracted attention, but they would not have changed the appearance and/or condition of the area. So, I decided to take ownership. I would be the solution. I did not tell anyone of this; it was probably against some rule or another. I decided that I would be responsible for the environmental quality of this twenty-foot swath. I did not care what other parts of the campus were like. They were someone else's problem. But each day, going from and to my car, I picked up litter.

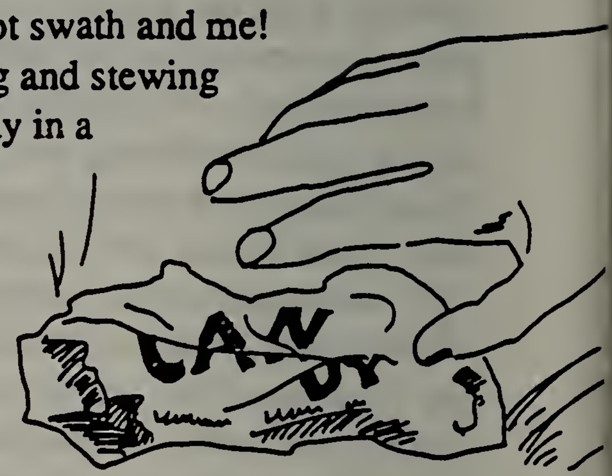
At first,.it was as much as I could conveniently carry. Then I made a game of it, limiting my picking to ten times each way. It was an exciting day when I realized I was picking faster than "they" were littering. Finally, the great day arrived when I looked back on my twenty feet of lawn - now perfectly clean.

Where did I put the litter? At first, I brought it into a waste basket in the building, or took it to the car to bring home. Then a curious thing happened. One day, large orange barrels appeared at each end of my swath. Someone in maintenance had become my silent conspirator - periodically emptying and replacing the barrels. He, too knew the wisdom of keeping a low profile about it all.

MY TWENTY FOOT SWATH (Cont.)

I've done this for several years now. Has general campus appearance changed? Not much! Have litterers stopped littering? No! Then if nothing has changed why bother?

Here lies the secret. Something has changed. My twenty-foot swath and me! That minute walk is a high spot of the day. Instead of fussing and stewing and storing up negative thoughts, I begin and end my workday in a positive mood. My perspective is brighter, I can enjoy my immediate surroundings - and myself - as I pass through a very special time space. "It" is better because of me. I am better because of "it". "We" enjoy the relationship. Maybe, even, "it" looks forward with anticipation to my coming.



My learning-and the twenty-foot swath-does not stop at the building door. There's an important principle that follows wherever I go. I cannot solve man's inhumanity to man but I can affirm, with a smile and a word of appreciation, those who feel burdened by the need to work at lowly jobs. I cannot right the imbalances of centuries of discrimination, but I can "lift up" someone who feels the weight of a poor self-image. I can treat women as equals without solving the problems of sex discrimination. I can seek out the social and economic litter in my own "twenty-foot swath" without demanding of myself that I "clean up the world."

I now practice a discipline of leaving each time-space capsule of my life a little better than when I entered it. Each personal contact, each event, each room I enter becomes a small challenge. I want to leave it improved, but more important, I am responsible to myself to be improved; and thereby, maybe-just maybe-my having been there will make life better for someone else.

I am becoming more and more disenchanted and suspicious of revolutionaries, crusaders, militants, and do-gooders. Many, if not most, seem to be more concerned about being right than being loving or effectual. The zealot, no matter how well-intentioned, often leaves a trail of wounded people while in pursuit of the cause.

Is this all too myopic-shutting one's eyes to the greater concerns? It does not need to be! I now have a twenty-foot swath. Next year it may be forty, or sixty, or eighty feet wide. Ten talents were not required of him who had been given only one. Too many people stumble by taking on causes too great for their level of discernment and discipline. They need to begin to catch the vision of the important promise, that the meek shall inherit the earth, not the indignant or frustrated.

Source: Reprinted with permission of the Covenant Press, 1982.

DESIGNING A COLLECTION SYSTEM

THEME:	An efficient system for handling recyclables will enhance the success of any collection program
GOAL:	Students will understand some of the design considerations for establishing a recycling facility
METHOD:	Studying and designing a recycling facility
SUBJECTS:	Art, Government, Industrial Arts, Social Studies
SKILLS:	Designing, inferring, interpreting, observing
MATERIALS:	Graph and drawing paper; colored markers; ruler; population figures; local maps; "Municipal Recycling Programs" profiles
TIME:	One week

GETTING STARTED

What kind of recycling program would be best meet the needs of your school or town?

PROCEDURE

1. Discuss with the class the different types of collection and processing programs for recyclables: household separation/curbside collection, drop-off centers, buy-back centers, and commercial collection. (Note: Refer to background material on Recycling for definitions of these programs.)

2. Have the students collect information on local waste and recycling practices to determine the needs for a recycling program. They should consider the amount of waste and recyclables being generated, potential markets for recyclables, funding sources, storage space, transportation costs, maintenance and management costs, community support, etc.

3. Have the students review the "Municipal Recycling Program" profiles for background information about successful programs in other towns.

4. Invite a local recycler, town or state official, or local planning or health board member to talk to the class and/or have the class visit a recycling facility.

5. Using this information, have the class decide on what type of program (buy-back, curbside, drop-off, etc.) would be best for the town (or school). Once this is determined, have them design a program for storage, collection, processing, etc. of the recyclable(s).

EXTENSIONS

1. Have the students prepare their plans and information to present to town officials or local planning groups.

2. Have the class research or visit recycling facilities in other communities. Have them interview a program representative asking questions such as: How did the program get started? What does it cost to operate and maintain? What is the level of community participation? What types of problems have been encountered? Based on this information have the students compare the programs and the advantages and disadvantages of each.

3. Have the students compare the cost effectiveness of the different recycling programs (e.g., curbside collection, drop-off centers, etc.)

Source: Adapted from AVR *Teacher's Resource Guide*

Curbside Programs

Bedford

Bedford is a suburban community west of Boston with a population of 12,000 and a substantial industrial base (mostly light industry and electronics). It generates approximately 6,000 tons per year (tpy) of residential waste. The town currently contracts with WTE Corporation for collection of its paper and glass recyclables. WTE collects paper twice a month and glass (pre-sorted by color) once a month. Residents provide their own recycling bins. Bedford had an existing curbside recycling program for ten years prior to this new arrangement with WTE. The town now has a three-year contract, running from July 1, 1988 to June 30, 1991, which costs $33,000 for the first year and $30,000 annually for the second and third years. The town would like to expand the program in the future to include tin, plastics, and returnables.

Approximately 660 tons of materials (10 percent of the waste stream) is collected annually under this program. Newspaper makes up 600 tpy and glass (clear and colored) another 60 tpy. Participation rates are estimated at 48 percent for newspaper and 20 percent for glass collection. Recycling is not mandatory.

Based on the town's collection costs of $47/ton to their trash hauler (BFI), and a tipping fee estimate of $65/ton for use of the North Andover NESWC combustion facility, Bedford saves approximately $10/ton or $6,000/year by recycling. All proceeds from the sale of recyclables go to the contractor, WTE.

(Source: Rich Warrington, Director of Public Works)

Chelmsford

Chelmsford has contracted with Environmental Ideas, a Vining Disposal Company, for curbside pickup of newspapers, cans, glass, and some plastic. Chelmsford is paying Environmental Ideas a flat fee of $186,000 per year, for three years, regardless of how many residents participate or how much is recycled. In addition to curbside pickup, the fee includes recycling bins for each of the 10,000 households (28,000 people), printing and postage for three informational flyers sent to every household (one via the recycling bin), and collection of recyclables at school and municipal buildings. Residents place recyclables curbside bi-weekly on the same day as regular trash pickup. Program participation is voluntary.

The town calculates that during the month of July 1989, 222.32 tons of material--approximately 136 tons of newspaper, 62 tons of glass, 17 tons of metals, and 7 tons of plastic--were recycled. Participation was high: 85 percent of Chelmsford's households joined in the program, which resulted in recycling approximately 17 percent of the town's solid waste.

The town produces approximately 16,500 tons per year of residential trash. To offset the costs of curbside collection of recyclables, the town would need to recycle 2,862 tons or 17.3 percent of their waste stream in the first year. The second year they would need to recycle 2,638 tons (16 percent), and the third year 2,447 tons (14.8 percent), to break even. If the community recycles 17 percent of its waste stream for all three years, the savings for the town will total $35,000. Each ton that is recycled allows the town to reduce their payments to BFI by $65/ton the first year, $70.50/ton the second year, and $76/ton the third year.

Chelmsford and Environmental Ideas share the net revenue from the sale of the recyclables.

(Source: Chelmsford Solid Waste Advisory Committee)

Montague

Montague, located in the heart of the Connecticut River Valley, has a population of 8,000 and a moderate industrial base. It generates approximately 12,000 tpy of solid waste. The town contracted with Ron Perkins of Waste Control to collect and haul trash to the town landfill at an annual cost of $131,000 for collection and $100,000 for disposal, or $17.76/ton. The town landfill has only one and one-half years of capacity left.

The town started a curbside recycling program two years ago which collects 756 tons of material per year, or 5.8 percent of the total waste stream: 400 tpy newspaper, 30 tpy glass, 250 tpy cardboard, and 76 tpy metal. Montague purchased 650 sets of two-tiered, blue and yellow bins, which cost $13.00 a set; residents buy the bins from the town for $3 a set. Glass and aluminum are mixed in the yellow tier, paper is put in the blue tier, and cardboard is set on the side. Residents put the bins out on the curb weekly, on the same day as their regular trash. Waste Control takes the recyclables to a transfer site next to the town landfill. Perkins' recycling contract costs $28,000 per year, or $37/ton.

The town receives no revenues from the sale of its recyclable materials. The newsprint is hauled to Erving paper, which takes it for free and the glass is marketed at New England CRINC in North Billerica. Bill Wood Enterprises of Northampton hauls the glass for free and keeps the revenues. Cardboard is collected by Hudson, who keeps the revenues, and metal is taken to Kramer Scrap in Greenfield. The participation rate is estimated to be between 50 and 70 percent.

Montague is in the process of designing a state-of-the-art recycling depot. The town has allocated $20,000 to build a Chase Modular recycling facility which consists of three concrete enclosed bins for paper, clear glass, and cardboard.

(Source: Silvio Baruzzi, Highway Superintendent)

Drop-Off Programs

Cambridge:

According to the Department of Public Works, the city of Cambridge, with an estimated population 89,733, currently pays BFI $70.10/ton in tipping fees for disposal of 47,000 tons each of residential and commercial solid waste every year. DEP's database lists city totals of 58,326 tons of residential trash and 58,326 tons of commercial garbage each year. The difference in these tonnage figures is probably the result of many commercial establishments and educational institutions not having either the city or BFI collect their waste.

In June 1989 the city launched a monthly drop-off program for newspaper, green, clear, and brown glass, and returnable containers. The DPW, in conjunction with a citizens advisory committee, runs the volunteer operation at two city locations in North and East Cambridge on the second Saturday of each month. During its first three months of operation, the city estimated that over 1,346 households participated and that 59 tons of newspaper and 10 tons of glass were collected.

The city pays North Shore Recycled Fibers, located in Salem, to recycle its newsprint. As is true in many other towns, the paper glut means the city is paying to get rid of its newsprint, although at a lower cost ($15/ton in July 1989) than for regular trash disposal. The glass is sold to Foster Forbes in Milford. In September 1989, the station began to accept aluminum. The citizens' advisory committee has put together an educational outreach program which includes newsletters, flyers, and press releases.

(Source: Cambridge Recycling Committee)

Somerville

A city of 71,790, DEP estimates that Somerville generates 46,664 tons of municipal solid waste and 46,664 of commercial trash annually. Its waste is processed at the Saugus RESCO combustion facility.

In February 1989, the Somerville Conservation Commission, through its recycling committee, launched a monthly drop-off program to collect newspaper, paper, and glass. Because of the program's success, the city now holds two drop-off collection days for residents every month. Plastics collection was added in the summer of 1989. During the month of June the program collected 23.86 tons of newspaper, 0.52 tons of paper, 5.92 tons of glass, and 0.45 tons of plastic. For that month the cost savings to the city, taking into account avoided disposal costs, revenue from the sale of materials, labor, transportation and equipment costs, and rentals amounted to $1,402.87. The cumulative cost savings for the five months of operation was $6,476.63.

The city purchased a plastics granulator for $4,000 in order to shred their plastic on location. The program accepts both PET and HDPE plastic including juice, detergent, antifreeze, motor oil, and milk containers. They also collect certain types of plastic baby products and containers for dishwashing liquid, household cleaners, and shampoo and other hair products.

(Source: Somerville Conservation Commission Recycling Committee)

Topsfield

Topsfield, an affluent rural community of 6,000 on the North Shore, generates about 3,000 tons of solid waste per year. Topsfield contracts with Robert C. Hitz of Gloucester to collect waste at the curb and take it to the town landfill. Annual collection costs are $86,100; landfill operating costs are $40,000, for a total of $136,000 annually or $45/ton.

A drop-off program was started more than five years ago by volunteers and is now run by the Public Works Department. The program recycles 490 tons per year or 16 percent of the town's waste stream. This includes 300 tpy of newspaper, 100 tpy of glass (clear, green, brown), and 90 tpy of scrap metal. Scrap metal is picked up curbside twice a year.

The drop-off site is open every Saturday between 8 AM to 1 PM and is monitored by a town employee. The town rents three roll-off containers, two for paper and one compartmentalized for different colored glass. The glass is crushed with a town backhoe. The recyclables are hauled away by vendors for free and the town receives no revenue from the sale of these materials. The recycling program costs $2,380 a year, or $4.86/ton. This includes $1,080 for rental of the three roll-off containers and $1,300 for labor.

(Source: Joseph Downing, Town Engineer and Hans Kahn, Board of Health)

KEEPING TRACK OF PAPER...COMPUTER STYLE

THEME:	Computers are a valuable tool for collating and recording information about resource use
GOAL:	Students will learn to record and project paper use in the school through computer programming
METHOD:	Creating a computerized monitoring program
SUBJECTS:	Computer Programing, Math
SKILLS:	Interpreting data, problem solving
MATERIALS:	Computer; sample computer program
TIME:	One hour to start, 30 minutes per week thereafter

GETTING STARTED

How might the computer be used to keep track of important information about how much material is recycled at your school?

PROCEDURE

1. Have the students set up a paper recycling program at your school (see "How to Start a School Recycling Program," pages 163-164). Alternately, have them collect and record the weight of paper products (in pounds or kilograms) discarded by your school in a given number of weeks.

2. Working individually or in teams, have the students write a computer program which records and stores information about the amount of paper collected each week. The program should include:

   a) the total number of students in the school;
   b) the average number of pounds or kilograms thrown away per student each week; and
   c) a running total and average of the above information.

(NOTE: Students should first try to write their own programs to determine the logic behind the actual step-by-step procedure. The sample program provided here, written in BASIC for an Apple computer, accomplishes the above tasks.)

EXTENSIONS

1. Using the figures below (provided by the Scott Paper Company), have the students determine how many trees--in the form of paper--are being consumed by the school each week:

In the South and East Coast regions of the U.S., an "average" tree used to make pulp for printing and writing paper would probably weigh about 500 pounds. This 500-pound tree, after processing through the paper-making system, would make approximately 100 to 150 pounds of paper.

2. Have the students determine the amount of energy in the waste paper being thrown away each week based on following figures:

In a typical pulp and paper mill, it takes approximately 27 million BTU's of energy to make one ton of paper. Another way of looking at this would be to say that one gallon of "oil equivalent" would make approximately 11 pounds of paper.

Source: Reprinted with permission from *A-Way With Waste*

KEEPING TRACK OF PAPER...COMPUTER STYLE

SAMPLE COMPUTER PROGRAM
(programmed in BASIC for an Apple computer)

```
LIST

10   REM *RECYCLE*
20   REM BY NATHAN M. WALTERS
30   REM ON FEBRUARY 20TH 19833
40   REM____________________
50   REM START PROGRAM
100  TEXT : HOME :D$ = CHR$ (4)
110  PRINT D$"OPEN WEEK0"
120  PRINT D$"WRITE WEEK0"
130  PRINT "0": PRINT "0": PRINT "0"
140  PRINT D$"CLOSE WEEK0"
150  HTAB 18: PRINT "MENU": PRINT
160  PRINT TAB( 10)"<1> STORE DATA"
170  PRINT TAB( 10)"<2> RETRIEVE DATA"
180  PRINT TAB( 10)"<3> EXIT PROGRAM"
190  VTAB 20: INPUT A
200  ON A GOTO 240,360,230
210  PRINT "?REENTER"
220  GOTO 190
230  HOME : END
240  D$ = CHR$ (4): HOME : INPUT "POUNDS OF PAPER ?";A
250  INPUT "NUMBER OF STUDENTS ?";B
260  INPUT "WEEK NUMBER ?";C
270  PRINT D$"OPEN WEEK"C - 1
280  PRINT D$"READ WEEK"C - 1
290  INPUT Y,Z,D
300  PRINT D$"CLOSE WEEK"C - 1
310  PRINT D$"OPEN WEEK"C
320  PRINT D$"WRITE WEEK"C
330  PRINT A: PRINT B: PRINT D + A
340  PRINT D$"CLOSE WEEK"C: CLEAR: PRINT "DONE"
350  PRINT "HIT ANY KEY TO CONTINUE";: GET PAUSE$: HOME : GOTO150
360  HOME :D$ = CHR$ (4)
```

```
370   INPUT "WEEK NUMBER ? ";A: PRINT
380   PRINT D$"OPEN WEEK"A
390   PRINT D$"READ WEEK"A
400   INPUT B,C,D
410   PRINT D$"CLOSE WEEK"A
420   HOME : PRINT "WEEK:"A: PRINT
430   PRINT "POUNDS OF PAPER:"B
440   PRINT "NUMBER OF STUDENTS:"C
450   PRINT "AVE. NO. OF LBS PER STUDENT:"B / C
460   PRINT "KILOGRAMS OF PAPER:"B / 2.2
470   PRINT "AVE.NO. OF KILOS PER STUDENT:";:Z = B / C: PRINT Z /     2.2
480   PRINT
490   PRINT "TOTAL NO. OF POUNDS:"D
500   PRINT "TOTAL STUDENT AVE."D / C
510   PRINT : PRINT "HIT ANY KEY TO CONTINUE";: GET PAUSE$
520   HOME : CLEAR : GOTO 150
/*END
```

Source: Reprinted with permission from *A-Way With Waste*

PAPER RECYCLING AND ITS BY-PRODUCTS

THEME:	Recycling conserves resources, saves money, and reduces waste, but it does not eliminate all pollution problems
GOAL:	Students will understand some of the technical problems encountered in the production of recycled paper
METHOD:	Making recycled paper and testing the water for pollutants
SUBJECTS:	Chemistry, Earth Science
SKILLS:	Experimenting, interpreting, measuring, predicting
MATERIALS:	Several sheets (at least 9" x 12") of different types of paper (newsprint, colored newsprint, white office paper, construction paper, envelopes, etc.); nylon stocking, cheesecloth, or millipore filter; "Recycled Paper and its By-Products" worksheet (NOTE: See Activity on PAPERMAKING for additional materials)
TIME:	One class to make the paper, one class to test the water for contaminants

BACKGROUND

Although recycling paper saves natural resources and energy, pollution problems still exist in the production of recycled paper. To be recycled, waste paper must be de-inked and have contaminants removed. Black printing inks used in newspapers are composed of about 30 percent pigment (usually carbon black) and about 70 percent petroleum-refined oil. Colored pigments in magazines--and increasingly in newspapers--contain heavy metals. New low-rub inks and laser printing cause additional problems because they are difficult to remove from paper. The papermaking process requires large amounts of water, all of which must be cleaned of contaminants. The remaining paper sludge also must be disposed of properly because petroleum distillates and heavy metals can remain present in this material. Both the contaminated water and sludge must be treated in a wastewater treatment plant before being released into the environment.

GETTING STARTED

Does recycling solve all our solid waste problems?

PROCEDURE

1. Divide the students into small groups. Using the procedure in the activity on PAPERMAKING, have each group make recycled paper out of a different type of waste paper.

2. Students should collect the water that drains through the screen while the paper is being pressed and check it for pollutants by testing the pH and noting color and sediment. Have each group strain the collected water and sludge through cheesecloth, nylon stocking, or a millipore filter, and examine what contaminants remain behind.

3. Have the students collect a sample of water after straining, and note its pH, color, and sediment. Set samples aside (do not disturb). Repeat pH, color, and sediment tests and observations after one, four, and twenty-four hours.

4. Have each group complete the "Recycled Paper and Its By-Products" worksheet and discuss the results as a class. (See Teacher's Page for answers to these questions.)

5. Have the students measure and compare the volumes and weights of both the scrap paper before it is torn up and placed in solution, and the new recycled paper they produced. The recycled paper should be dried before weighing and measuring. Does the recycled paper weigh as much as the original paper? Why is there a difference? Students should also compare the length of fibers and appearance of both types of paper.

EXTENSIONS
1. Visit a paper-making plant.

2. Research the pollution control methods used in paper-making plants.

Sources: Adapted from AVR *Teacher's Resource Guide*; Paul Emond, Environmental Engineer, DEP

RECYCLED PAPER AND ITS BY-PRODUCTS

1. What materials are in the sediment and sludge?

2. What is causing the discoloration of the water?

3. Is the strained water less polluted than the unstrained water? Why?

4. Should the remaining paper sludge be treated as solid waste or hazardous waste?

5. How can we reduce pollution problems?

RECYCLED PAPER AND ITS BY-PRODUCTS
Teacher's Page

1. What materials are in the sediment and sludge?

The sludge contains primarily wood fibers (paper) that were too small to be recovered in the papermaking process. Any materials that were in the paper before recycling (including petroleum distillates and heavy metals), will be in the new recycled paper, the sludge, or the water discharged after processing.

2. What is causing the discoloration of the water?

Some of the inks, fibers, and other materials in the paper being processed get suspended or dissolved in the process water, causing discoloration.

3. Is the strained water less polluted than the unstrained water? Why?

The strained or filtered water is less polluted than the unstrained water because some suspended materials have been removed. A finer filter will remove more suspended solids, resulting in less polluted water.

4. Should the remaining paper sludge be treated as solid waste or hazardous waste?

It depends on the concentrations of chemicals in the final sludge. If the original paper before recycling contained a minimal amount of hazardous materials (e.g., heavy metals, petroleum, etc.), the final sludge will also be low in these materials. The sludge, therefore, would contain mostly wood fibers and be considered a solid waste and not a hazardous waste.

5. How can we reduce pollution problems?

In this context, pollution problems can be reduced by:

- **a. <u>Source Reduction</u>: Hazardous materials used in the original paper manufacturing process should be removed.**
- **b. <u>Waste Minimization</u>: Additional pollution control methods can be employed to remove and concentrate the hazardous materials in the sludge.**
- **c. <u>Beneficial Reuse</u>: The sludge waste can be reused by composting it for use as a low-grade fertilizer.**

MICROORGANISMS: BACTERIAL RECYCLERS

THEME:	Microorganisms are essential to the recycling of organic matter
GOAL:	Students will relate the importance of healthy microorganisms to composting
METHOD:	Observing and sketching slide samples under the microscope
SUBJECTS:	Biology
SKILLS:	Comparing, observing
MATERIALS:	Trays or pans; soil; glass slides; water; containers; violet or methylene blue; erythrosine or eosine; microscopes; wax pencil
TIME:	Three weeks

GETTING STARTED

What types of organisms are responsible for the composting process?

PROCEDURE

1. Divide the students into small teams. Have each group fill one tray with dry soil and a second tray with soil plus 5 to 10 percent organic matter, well mixed. Insert six slides vertically into each container as shown in Figure 1.

Figure 1: Slide Placement in Tray

2. Six slides in each container will permit observation of each sample at the end of one, two, and three weeks. Each observation requires two slides, one stained dark and one stained light. Adjust the moisture content to about 20 percent water by adding a volume of water corresponding to about 1/5 of the volume of soil. Keep moisture content as constant as possible by adding water as needed.

3. After one week, have students examine two slides from each container according to the following procedure. Dig soil away from one side of the slide, then tilt the same slide toward the hole and lift it out.

4. The slide will now have a film of soil and microorganisms on one side. Have the students clean the other side with a cloth and label the slide with a wax pencil. Repeat for a second slide.

5. The preparation on the slide is "fixed" by passing the slide over a flame--one or two passes should be sufficient. Stain one slide dark, using gentian violet or methylene blue. Stain the other slide light, using erythrosine or eosine.

6. Have each team examine their slides for bacteria with the low and high powers of a microscope. If present, spirilla will probably not be seen unless the field is darker. Have the students sketch what they see and compare them to the diagrams in Figure 2 to identify the morphological class of the bacteria. Are there differences in the number and types of microorganisms in each of the samples?

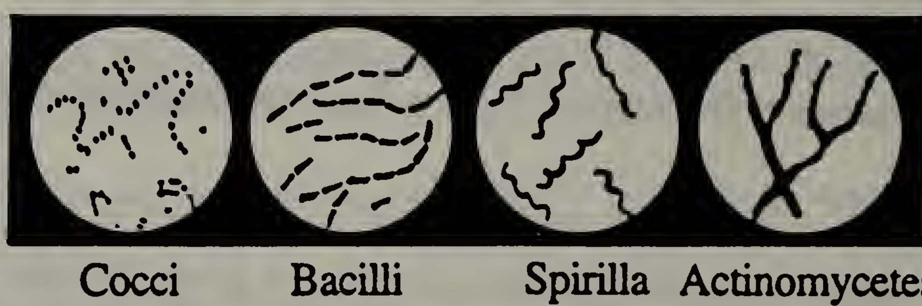


Figure 2: Common Morphological Classes of Bacteria

7. At the end of the second week, repeat the procedure with another pair of slides from each sample. Have the students determine if the number and types of bacteria in the samples have changed significantly. WHat might account for any observed changes?

8. At the end of the third week, repeat the procedure and make further comparisons. Have each team relate their observations and conclusions to composting.

Source: Reprinted with permission from *Oscar's Options*

MAKING GOOD COMPOST

THEME:	Composting improves soil structure and fertility and reduces the volume of household solid waste requiring disposal by other means
GOAL:	Students will examine different criteria which affect the quality of compost and learn how to construct a good compost pile
METHOD:	Constructing and comparing different compost treatments
SUBJECTS:	Biology, Horticulture
SKILLS:	Analyzing, experimenting, predicting
MATERIALS:	Organic waste; soil; five 30-gallon buckets; thermometer; "Backyard Composting" brochure; "Necessary Components of a Compost Pile" handout; "Making Good Compost" worksheet
TIME:	One hour for set-up, several months for observation

GETTING STARTED

What are the essential ingredients for a successful compost?

PROCEDURE

1. Prior to starting this experiment, have the class review DEP's brochure, "Backyard Composting" and the handout, "Necessary Components of a Compost Pile." Choose the method which fits your time and budget limitations. Keep compost piles about one cubic yard in size, or, if necessary, use five 30-gallon buckets with holes drilled in the sides.

2. Working in small teams, have the students start six compost piles, each reflecting a unique set of criteria as listed on the "Making Good Compost" worksheet. Organic wastes can include grass clippings, leaves, manure, weeds, hay, sawdust, household kitchen wastes (excluding bones, meat, or grease that could cause odors or attract pests).

3. Have each group prepare a log book and record the daily temperature of its pile and make other observations for a period of several weeks or months.

4. Discuss the results, addressing questions such as: Which experimental compost was most successful? How is composting related to the concept of recycling? How can composting reduce waste? Where does composting occur naturally?

EXTENSIONS

1. Have the students research different natural cycles (e.g., the nitrogen cycle, the carbon cycle, etc.), how they work and how they relate to composting. Have students prepare a handout explaining and illustrating the cycle they researched. Group students by the type of cycle they examined and have each team prepare a bulletin board display explaining in text and graphics how the cycle works and its importance to composting and other solid waste disposal methods.

2. Have students test the effects of the different compost treatments on plant growth.

Sources: Adapted from AVR *Teacher's Resource Guide*; *A-Way With Waste*

BACKYARD COMPOSTING

What is Composting?

Composting is a controlled process of decomposition of organic material. The end product is a rich, biologically active humus that can be used to improve soil quality. Compost contains varying amounts of nitrogen, potash, phosphorus, and other soil nutrients, depending on the material from which it was made.

Harvest your yard waste!

Why Should I Make Compost?

Composting can be the most convenient, beneficial and inexpensive way to handle your yard waste. Instead of adding to the solid waste disposal problem, you can improve the quality of your soil and the health of the plants growing in it by composting at home. If you have a garden, a lawn, trees, shrubs or even planter boxes, you will benefit from making compost.

Why Does Compost Make Soil Healthier?

By using compost you return organic matter to the soil in a usable form. Organic matter improves soil structure (which allows better root penetration), increases water and nutrient-holding capacity, and adds essential nutrients to the soil. Compost also provides a good environment for earthworms and other beneficial soil organisms. All of these effects make vegetation healthier and more productive. Healthy plants help clean our air, conserve our soil, and beautify our landscapes.

How Does Composting Help Massachusetts?

Leaf and yard wastes make up about 20% of all household wastes, which use up valuable space in Massachusetts landfills - space that is running out fast! Leaf and yard wastes lower the efficiency of incineration systems because of their high moisture content, and increase ash and sulfur dioxide emissions. By recycling these wastes naturally at home, you can help protect the environment, save money, and improve your own soil at the same time.

What Should I Compost?

Yard wastes such as leaves, grass clippings, weeds and the remains of garden plants make excellent compost. What you add to your compost pile will depend on what is available and sanitary code restrictions (consult your local Board of Health for restrictions on composting). Particular care must be taken in urban areas to avoid attracting pests to the compost pile. Materials that should not be composted in your backyard included meat, bones, fatty food wastes (cheese, grease, oils) dog and cat litter, and diseased plants.

How to Make Compost

Making compost is like cooking a meal - there are unlimited variations and recipes. The information in this brochure will get you started, but soon your own experience will enable you to tailor a method to fit your needs. Just remember to keep the essentials of composting in mind - air, moisture, heat, sufficient volume (to hold heat) and suitable organic material

For More Information

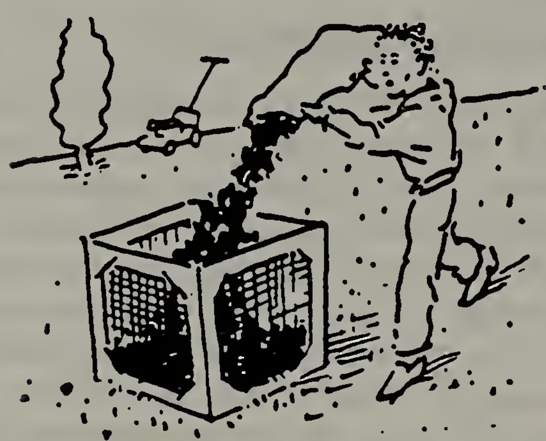
about composting, contact the Compost Staff at the Massachusetts Department of Environmental Protection's Division of Solid Waste Management, (617)292-5834.

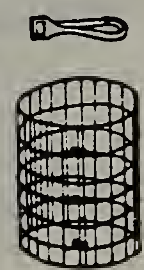
How to Begin - *Choose a Bin*

Enclosed compost piles keep out pests, hold heat and moisture well, and have a neat appearance, so they are generally preferable to open piles. Bins are very simple to make, or they can be purchased through most gardening catalogues. If you live in an urban area, the bin must be rodent proof.

Bins can be made of wood, wire, concrete blocks, or a combination. Here are some options.

Holding Bins





Woven Wire Bin

These portable containers are the simplest way to compost. Turning is optional.

Turning Bins

This is a series of three or more bins that allows you to make compost in a short time by turning the materials on a regular schedule.

For more information on bins and methods, see the *Rodale Guide to Composting* in your library.

Be Step Wise

1. Choose a convenient, shady spot with good drainage that will accommodate a pile of at least 3 feet on a side.
2. Gather the materials to be composted, keeping a good carbon to nitrogen ratio in mind. In general, fresh green plant material is high in nitrogen and dried leaves and stalks are high in carbon. Mixing them 2 to 1 is optimal, but there is a wide range of acceptable blends.
3. Mix materials thoroughly and put them in the bin. If all materials aren't on hand at the same time they may be added in alternating layers (high nitrogen/high carbon) with a sprinkling of soil in between. Sprinkle the pile with water as it is constructed so that it is thoroughly moistened without being soggy. The pile should not exceed 5 feet in height.
4. A properly made heap should reach temperatures of up to 150 F within a week. Turn the pile within 2 weeks after it is built to introduce a fresh supply of oxygen. Turn thoroughly so that the outside materials go to the center of the new pile. Add water if necessary.
5. Frequent turnings will accelerate decomposition. In general, a pile started in summer or fall should be ready for use the following spring.
6. Compost is ready to use when it is dark brown, crumbly and earthy-smelling. The temperature inside the pile will have dropped and stabilized.

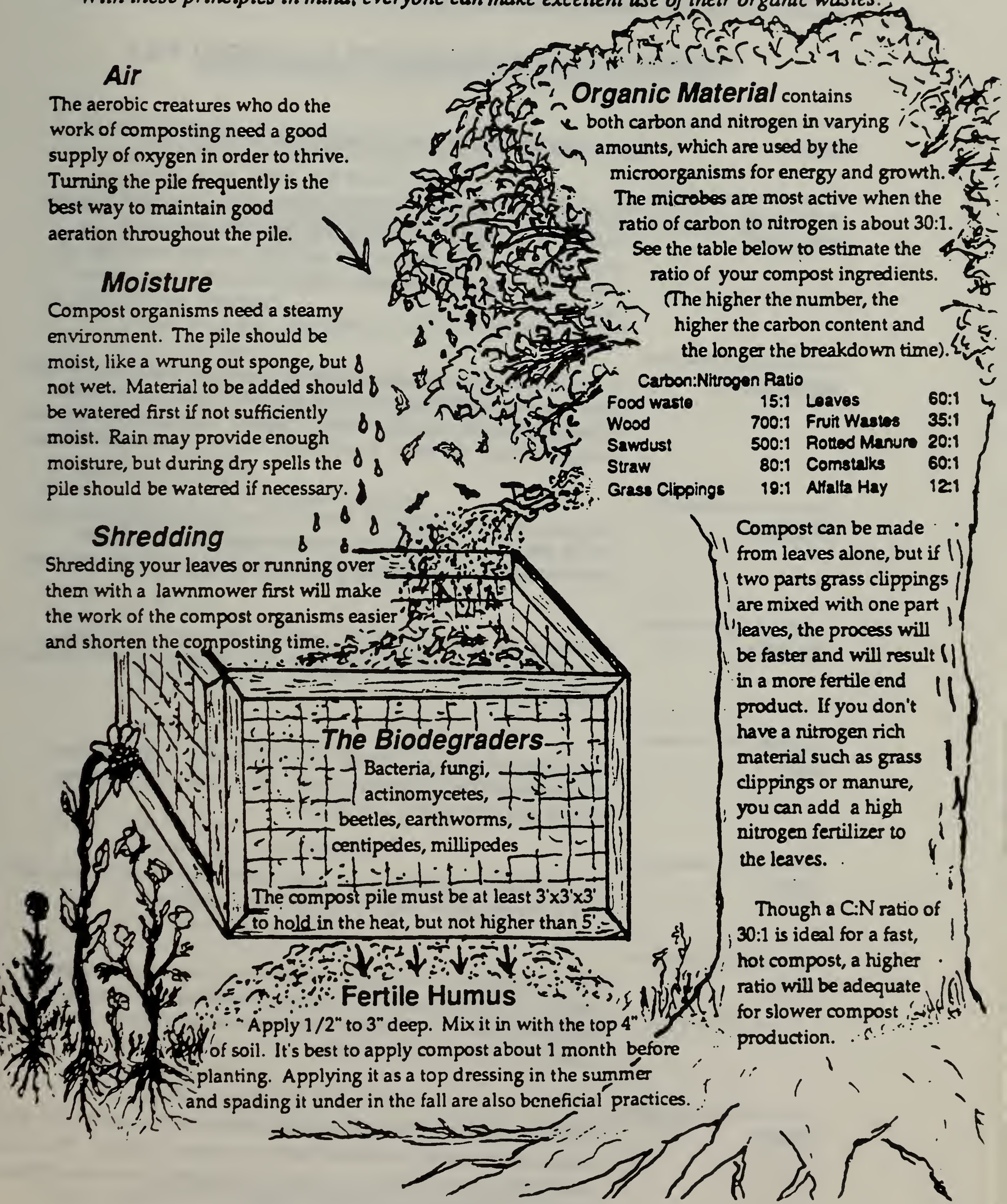
What About Mulching?

Grass clippings, leaves and woody yard wastes can b used as a mulch to increase water retention and for weed and erosion control. Simply spread the materia beneath plants. Woody materials should be chopped or shredded before spreading. Yard wastes will work first as a mulch and then as a soil enrichment as decomposition proceeds. Grass clippings are ideal fo mulch. However, grass which has been treated with herbicides should not be used as a mulch immediatel after mowing; composting them will break down the herbicides. Alternatively, the nutrients in the grass clippings can be returned directly to the lawn by leaving the clippings on the lawn, where they will quickly decompose.

This brochure is based in part on material published by the City of Seattle Engineering Department's Solid Waste Utility and the Seattle Tilth Association.

Composting Leaf and Yard Waste

With these principles in mind, everyone can make excellent use of their organic wastes.



Air

The aerobic creatures who do the work of composting need a good supply of oxygen in order to thrive. Turning the pile frequently is the best way to maintain good aeration throughout the pile.

Moisture

Compost organisms need a steamy environment. The pile should be moist, like a wrung out sponge, but not wet. Material to be added should be watered first if not sufficiently moist. Rain may provide enough moisture, but during dry spells the pile should be watered if necessary.

Shredding

Shredding your leaves or running over them with a lawnmower first will make the work of the compost organisms easier and shorten the composting time.

Organic Material contains both carbon and nitrogen in varying amounts, which are used by the microorganisms for energy and growth. The microbes are most active when the ratio of carbon to nitrogen is about 30:1. See the table below to estimate the ratio of your compost ingredients. (The higher the number, the higher the carbon content and the longer the breakdown time).

Carbon:Nitrogen Ratio

Food waste	15:1	Leaves	60:1
Wood	700:1	Fruit Wastes	35:1
Sawdust	500:1	Rotted Manure	20:1
Straw	80:1	Cornstalks	60:1
Grass Clippings	19:1	Alfalfa Hay	12:1

Compost can be made from leaves alone, but if two parts grass clippings are mixed with one part leaves, the process will be faster and will result in a more fertile end product. If you don't have a nitrogen rich material such as grass clippings or manure, you can add a high nitrogen fertilizer to the leaves.

Though a C:N ratio of 30:1 is ideal for a fast, hot compost, a higher ratio will be adequate for slower compost production.

The Biodegraders

Bacteria, fungi, actinomycetes, beetles, earthworms, centipedes, millipedes

The compost pile must be at least 3'x3'x3' to hold in the heat, but not higher than 5'.

Fertile Humus

Apply 1/2" to 3" deep. Mix it in with the top 4" of soil. It's best to apply compost about 1 month before planting. Applying it as a top dressing in the summer and spading it under in the fall are also beneficial practices.

NECESSARY COMPONENTS OF A COMPOST PILE

SOIL: contains microorganisms that help decomposition.

ORGANIC WASTES: such as leaves, food scraps, and grass clippings. Wastes should be varied, including materials with both carbon and nitrogen. By alternating layers of high-carbon and high-nitrogen materials, you can create good environmental conditions for decomposition to occur.

NITROGEN: many of the organisms responsible for decomposition need nitrogen, thus nitrogen is necessary for rapid and thorough decomposition. Nitrogen is found naturally in many organic wastes, such as manure and green grass clippings, as well as in many commercial fertilizers.

WORMS: they eat the waste, helping to break it down, make droppings, which enrich the soil, tunnel through and aerate the waste, facilitate decomposition, and eventually die and become part of the compost.

WATER: necessary for normal functioning of life. Too much water in a compost pile may make it soggy and slow decomposition by reducing needed oxygen.

AIR: the biological activity of fungi, bacteria, small insects and other organisms results in decomposition. Most biological processes require adequate amounts of oxygen.

TIME: decomposition takes time. To speed up decomposition, aerate your pile every few days; otherwise, just leave it and wait.

HEAT: heat is produced by chemical reactions resulting from increased biological activity that occurs during decomposition. Heat helps sanitize compost by killing certain organisms e.g., weed seeds, pathogens, harmful insect larvae.

MASS: in order to generate enough heat for optimal decomposition, the pile must contain at least one cubic meter of organic material. Thus, the temperatures generated in an aquarium compost pile may be different from those generated in one that is larger.

WORKSHEET — MAKING GOOD COMPOST

A. Low In Nitrogen

1) NO ORGANIC WASTE THAT IS HIGH IN NITROGEN
2) keep moist, don't soak with water
3) turn regularly, every three or four days at first, then once a week.
4) include a mixture of ingredients: garbage, clippings, leaves, weeds, etc.
5) critters

B. Not Enough Moisture

1) include manure and contents which are high in nitrogen
2) turn regularly
3) have a good mixture of ingredients
4) DO NOT WATER, or add moist garbage
5) critters

C. No Air Circulation

1) include material high in nitrogen
2) keep moist
3) DO NOT TURN
4) balanced mixture of ingredients
5) critters

D. Too Much Of A Single Ingredient

1) include nitrogen material
2) keep moist
3) turn regularly
4) USE ALL BONE MEAL OR MANURE
5) critters

E. No Little Critters

1) use potting soil (sterilized)
2) turn regularly
3) keep moist
4) good mix of ingredients
5) NO CRITTERS

F. Good Compost Pile

1) include nitrogenous material (manure and blood meal are good sources)
2) keep moist
3) turn regularly
4) include a good mix of ingredients which are layered
5) critters, (earthworms should be added after temperature drops)

Source: Reprinted with permission from *A-Way With Waste*

NOT IN MY BACKYARD

A PUBLIC HEARING TO SITE A RESOURCE RECOVERY FACILITY

THEME:	Building new waste disposal facilities usually raises strong public opposition
GOAL:	Students will examine the social, economic, and environmental issues raised during the proposal for building a combustion facility in their community
METHOD:	Mock town meeting
SUBJECTS:	Economics, Science, Social Studies
SKILLS:	Analyzing, communicating, problem solving
MATERIALS:	Journal articles (see list under Procedure)
TIME:	Two periods, plus preparation time

BACKGROUND

When new waste disposal facilities need to be built, the prevailing public sentiment has been "Not-In-My-Backyard" or NIMBY. When surveyed, most Americans consistently rank solid waste management as among the top local priorities. Even though this is true, strong public opposition remains to placing facilities in one's own community. Opposition to combustion facilities and landfills rests on widespread concern about the environmental impact of the facility. The fear of groundwater contamination is the primary worry about siting landfills, while air emissions and problems with ash disposal are seen as the threats from combustion facilities. Increased public acceptance of waste facilities will depend on the industry's ability to alleviate environmental anxieties through education.

....Edward Byers, "Now Entering the Age of NIMBY?"
Waste Age Magazine (January 1990)

GETTING STARTED

Present the students the following scenario: Your town has a solid waste disposal problem and is considering construction of a combustion facility to alleviate the situation. Is this a wise decision? What would be the advantages and disadvantages to your community?

PROCEDURE

1. Explain to the students that there will be a public hearing held by town officials to consider whether or not a combustion facility should be built in the community. Testimony from different groups will be heard at the meeting.

2. Divide the class into four groups as follows:

* Town government officials (e.g., Selectmen or Town Council)
* Citizens group (including environmental groups)
* Project developer (including chemists and environmental engineers)
* Board of Health official or Town Planner

Groups should research the issue and prepare to represent that viewpoint at town meeting. Assign one spokesperson from each of the last three groups who will present the group's position. Each local government official or town council member will be allowed to ask questions of the group following the presentation.

3. Obtain and distribute the articles listed below to help students formulate their position for the hearing.

Waste Age Magazine
Suite 1000
1730 Rhode Island Ave., NW
Washington, DC 20036

"Now Entering the Age of NIMBY?" by Edward Byers, January 1990, pp. 36-38.
"YIMBYism is Coming, But..." by Marvin G. Katz, January 1990, pp. 40-41.
"A Micro Study of NIMBYism" by A.L. Rydant, January 1990, pp. 44-45,48,50,52

Funding Sites for Waste-to-Energy" by Frank Cross, Phil O'Leary and Patrick Walsh Lesson Six, University of Wisconsin/Waste Age Course, pp. 29-33.

4. When the groups are ready to make their presentations, assemble the entire class. Seat town council members to face the audience. Each group spokesperson should present a position statement, followed by an opportunity for questions and discussion. At the end of the meeting the council votes on the proposal to site the facility.

EXTENSIONS
1. Use this same format for siting a landfill in a community.

Source: Adapted from *Oscar's Options*

BURY THAT TRASH

THEME:	Most solid waste is disposed of in landfills
GOAL:	Students will understand how a landfill is operated, managed, and regulated
METHOD:	Visiting a landfill and/or interviewing a landfill expert
SUBJECTS:	Language Arts, Math, Science, Social Studies
SKILLS:	Estimating, interviewing, observing, recording
MATERIALS:	"Bury That Trash" questionnaire
TIME:	One hour, excluding time for field trip

GETTING STARTED

What happens to waste when it gets to a landfill? How are landfills operated?

PROCEDURE

1. Contact a municipal or commercial landfill and obtain permission for your class to visit. Arrange for the site manager or landfill personnel to guide your class around the site and to answer questions. A list of landfill disposal sites in Massachusetts can be obtained from DEP's Division of Solid Waste Management.

2. If you are unable to take a trip, invite a solid waste management representative to your class as a guest speaker. Possibilities include: a waste disposal site operator, a private waste hauler, a Board of Health officer, a public works official, a state Department of Environmental Protection official, or a regional solid waste planner or manager.

2. Prior to the field trip or speaking engagement, have the students develop a list of questions, such as those listed on the "Bury That Trash" questionnaire, and investigate possible answers. Send the questions to the guide or guest speaker in advance so they can prepare responses.

3. Based on the interviews, have the class determine the costs involved in collecting and disposing of waste.

4. Present the following problem to the class and discuss the implications of the results.

A new landfill is being sited in your town. You are the local landfill expert and have been asked to answer some questions about the project. Assume the following:

* Each resident produces 1.1 pounds of trash/day or 405 pounds/year.
* 800 pounds of trash = one cubic yard of landfill space
* One acre of landfill space, ten feet deep = 16,133 cubic yards capacity.

A) Determine the amount of space in both cubic yards and acres that will be needed to serve your community for 20 years, 50 years, 70 years.

B) Your town is seriously considering a 50-acre site for its new landfill. They have asked you to determine how long it will last assuming the amount of trash generated per person and population of your town remain constant over time.

C) How would population growth affect the life of the new landfill?

5. Have the students write essays which address some or all the questions discussed with the landfill expert. Encourage students to include their personal views and thoughts on some of the issues associated with landfills.

6. As a class, discuss some of the questions and issues that came up in the essays. Additional discussion questions include: Are landfills the best way to dispose of trash? What are the merits and potential problems associated with landfills? Would you mind living near one? How do modern sanitary landfills differ from open dumps? How might we reduce our need for landfill space?

EXTENSIONS
1. Design a use for your landfill when it closes.

Sources: Adapted from Wisconsin *Recycling Study Guide*; AVR *Teacher's Resource Guide*

BURY THAT TRASH - QUESTIONS TO CONSIDER

- Where is the garbage from your school or home taken?

- How does it get there?

- Why was the landfill located on this site? What factors must be considered when a site is selected?

- What tests were done at the site before it was opened? What were the results?

- What laws govern solid waste disposal in your community?

- Is the landfill an engineered or unengineered site?

- Who owns the landfill? When did it open? What was the cost of constructing it?

- Who does the site serve? Who can bring wastes to the landfill?

- What is the tipping fee for using the landfill?

BURY THAT TRASH - QUESTIONS TO CONSIDER (Cont.)

- How much does it cost to take care of trash once it's in the landfill?

- How much solid waste is disposed of at this site daily, weekly, yearly?

- Who monitors what is dumped at the site? Are any of the materials hazardous?

- What happens to the trash once it's dumped in the landfill? How is the site managed for control of blowing trash, erosion, surface runoff, and leachate?

- Are tests performed regularly at the site (groundwater, soil, methane gas)?

- How many years is the landfill expected to last? How much time does the community have to find a new site or an alternative means of disposal?

SOIL MAKES A DIFFERENCE

THEME:	Leachate from landfills can threaten ground and surface water supplies
GOAL:	Students will learn that the underground movement of leachate is influenced by soil type
METHOD:	Comparing the waterholding capacity of various soils
SUBJECTS:	Geology, Science
SKILLS:	Observing, recording
MATERIALS:	Plastic containers with covers (e.g., empty juice or milk jugs); pebbles, gravel, coarse sand, fine sand, topsoil, clay, or other types of soil; a watch or clock with second hand; water; bowls; measuring cup; powdered paint; "Landfill Soil" worksheet
TIME:	One hour

BACKGROUND

The geology and soil underlying and surrounding a landfill influences the direction and rate flow of leachate flow and whether it will threaten water supplies. The ability of a material such as soil to transmit water is called permeability. Leachate will tend to move quickly through highly permeable soils such as sand or gravelly loam, while impermeable clays present an obstacle to quick drainage. This is one avenue for leachate to contaminate groundwater supplies.

For additional information on groundwater see Groundwater Informational Flyer #8, produced by the Massachusetts Audubon Society.

GETTING STARTED

Ask the students whether the type of soil or bedrock beneath a landfill influences the flow of leachate? How does it influence the contamination of nearby water supplies?

PROCEDURE

1. Divide the students into small teams to set up experiment. To prepare containers, perforate the cap of each plastic jug and cut off the bottom end. Replace the cap, turn the container upside down, and fill it about two-thirds full with one kind of soil. Repeat with different types of soil, labelling each jug as to soil type. In addition, the instructor should prepare a separate container in which several tablespoons of powdered paint have been buried in a well in the soil. Cover the paint completely so that the students do not know the paint is there.

2. Have each team select one container and remove the cap before placing the mouth end in a bowl. Noting the time, pour in one pint of water. Each team should record the time at which water starts dripping into the bowl and the time when it stops. Have each team measure the amount of water that came through and record with time calculations for later analysis. Was the amount of water that dripped through more or less than was initially added? What might this say about the soil?

3. Have teams repeat the experiment with each type of soil. Students should compare the data from all their trials and write a brief description of each type of soil and its properties.

4. Repeat the experiment a third time with the soil containing the paint. What color was the water that drained out? Discuss with the students that there are many chemicals, like the paint, that are buried in landfills and not detectable to the eye. When water passes through a landfill and the underlying soil it can pick up traces of chemicals, heavy metals, bacteria, and various products of decomposition. The type of soil surrounding the landfill determines the rate and direction of leachate flow. Discuss this process with the class addressing questions such as: Which type of soil is most suitable for a landfill site? Why? What kinds of problems could result from underground movement of leachate? How might these be solved?

EXTENSIONS

1. Have the students research techniques which have been developed to inhibit leachate formation, as well as those designed to reduce the potential for groundwater contamination. Possible topics include impermeable landfill liners, leachate collection systems, and capping of closed landfills. Have students present their findings to the class as the basis for a discussion on the effectiveness of these techniques or other relevant issues they have discovered.

Sources: AVR *Teacher's Resource Guide* and *Oscar's Options*

LANDFILL SOIL WORKSHEET

SOIL TYPE	TIME ELAPSED BEFORE PERCOLATION	TIME ELAPSED UNTIL PERCOLATION IS COMPLETED	AMOUNT OF WATER RELEASED FROM SOIL	CONCLUSIONS

Source: Reprinted with permission from *Oscar's Options*

COMMUNITY WASTE PLAN

THEME:	Communities have different disposal options available to them for managing solid waste
GOAL:	Students will gain an understanding of different waste management methods, and of the costs, benefits, and drawbacks associated with each option
METHOD:	Researching waste processing methods
SUBJECTS:	English, Environmental Education, Math, Science, Social Studies
SKILLS:	Analyzing, communicating, problem solving
MATERIALS:	"Community Waste Plan" worksheet
TIME:	One class period, plus additional time for research

GETTING STARTED

Ask the students what solid waste management method(s) are available in your municipality? Which are the best suited for your community's needs?

PROCEDURE

1. The Commonwealth of Massachusetts prescribes waste management based on the following hierarchy:
   * reducing the amount of waste produced;
   * recycling and/or composting certain components of the waste stream;
   * incinerating the balance of the waste stream which cannot be reduced or recycled, but can be safely burned;
   * landfilling only that waste which cannot be reduced, recycled, or burned.

Divide the students into groups and have each team research one of these four waste management methods: Source Reduction, Recycling and Composting, Combustion, and Landfilling. Encourage them to contact and obtain information from municipal and state officials, local recyclers, solid waste management planners, and environmental groups.

2. Have the students consider the following points during their evaluations:

   a) the amount and composition of the community's waste stream, as well as the waste disposal method(s) currently employed

   b) the environmental, economic, health, and political issues associated with the disposal method, including costs per ton of processing and costs of constructing and maintaining the facility and program

c) the long-term viability of the method, taking into consideration population growth, economic impacts, and environmental consequences

d) public acceptance and endorsement to use and participate in the program.

3. Have each group select a spokesperson to present their findings to the class. Analysis and discussion should include benefits and drawbacks for each waste management method.

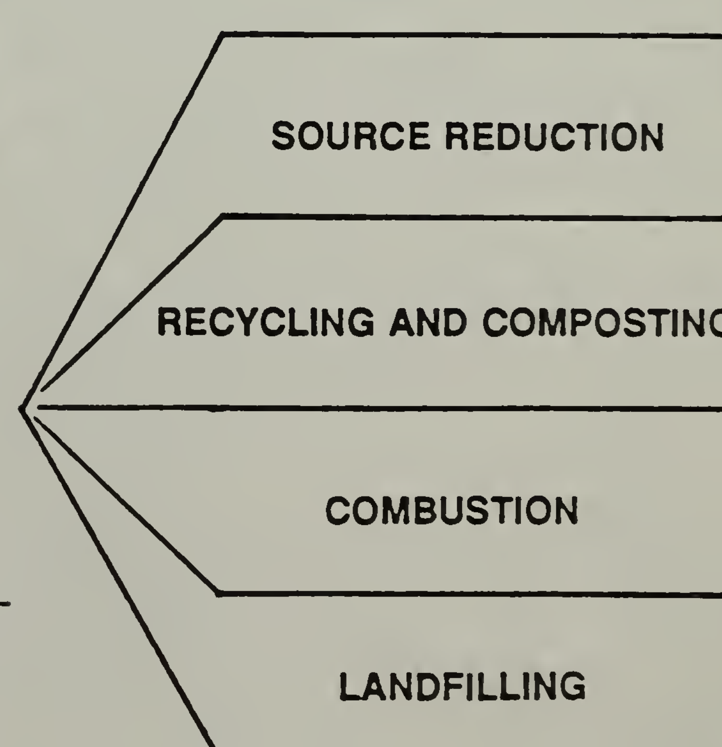
EXTENSIONS

1. Visit a resource recovery/combustion facility, recycling facility, or landfill, or invite a representative from one of these facilities to come and speak to the class.

COMMUNITY WASTE PLAN WORKSHEET

Questions to consider:

1. What percentage of the waste stream can this process handle?
2. What is the cost per ton of processing the waste by this method?
3. What is the expense of constructing this facility or starting this program and how can it be financed? What are the estimated costs of maintenance?
4. What, if any, are the environmental or public health problems associated with the method? Do the benefits of the method outweigh the problems associated with it?
5. What are the experiences of other communities which are using this method?
6. How many years into the future are you planning to use this method? (Be sure to consider population growth, long-term economic trends, and potential environmental impacts.)
7. Is the method convenient and will the public endorse its use and actively participate in the program?



APPENDICES

GLOSSARY

aerobic: able to live and grow in the presence of free oxygen; aerobic bacterial decomposition results in the conversion of organic wastes to compost

anaerobic: able to live and grow only in the absence of free oxygen; anaerobic decomposition of organic wastes by bacteria results in the production and release of methane gas

aluminum: a light silvery-white metal made from bauxite ore that can be easily bent or crushed, but is highly resistant to oxidation (rust)

aquifer: an underground geologic formation in which the cracks in rock, sand, soil, or gravel are filled with water

bacteria: single-celled living organisms; some types can cause disease and others break down solid waste

bioaccumulation: concentration of chemicals in the fatty tissues of living organisms, which may move up the food chain over time

biodegradable: the property of a substance that permits it to be broken down naturally by microorganisms into simple, naturally-occurring compounds such as carbon dioxide and water; includes most organic wastes such as food and paper

BTU: British Thermal Unit, or a unit of heat required to raise the temperature of one pound of water one degree Fahrenheit (For example, it takes 70 BTUs to heat a cup of water from room temperature (72°F) to boiling)

carbon dioxide: a common gas, CO_2, formed by respiration, combustion, and decomposition; comprises 0.03 percent of air

combustion: burning of waste materials, fuels, etc.

compost: decayed organic waste which changes into humus

composting: the conversion of organic materials to humus by microorganisms; an effective solid waste management method for reducing the organic portion of waste, including lawn clippings, leaves, kitchen scraps, and manure

conservation: the planned management and wise use of natural resources to minimize loss, exploitation, neglect, and waste

consumer: a person who buys goods or services

contaminants: compounds that pollute, making the original substance impure or unusable

decompose: to break down into component parts or basic elements; decomposition of organic waste materials by bacteria is an essential life process because it makes essential nutrients available for use by plants and animals

demolition debris: waste materials produced during construction or remodelling including items such as used lumber, masonry, sheetrock, shingles, insulation, etc.

ecology: the scientific study of the relations of living things to one another and to their environment

ecosystem: a system made up of a community of living things and the physical and chemical environment in which they interact

environment: all the conditions, circumstances, and influences surrounding and affecting the development or existence of people or other living things

fly ash: small particles of ash and soot which are collected by pollution control devices during the incineration of solid wastes

food chain: a succession of organisms in a feeding chain in which food energy is transferred from one organism to another as each consumes a lower member and is, in turn, preyed upon by a higher member

garbage: spoiled or waste food that is thrown away; generally defined as wet food waste and excludes dry material (trash); this term is often used interchangeably with the word "trash"

glass: a transparent, inorganic, non-porous, impermeable material produced by melting silica sand with limestone, with the addition of soda ash for strength and chemical durability

groundwater: water beneath the earth's surface that moves between soil particles and rock; supplies wells and springs

habitat: place where a plant or animal normally lives; part of an ecosystem

hazardous waste: waste which results in special problems to living creatures or the environment because it has one or more of the following characteristics: (a) poisonous, (b) explosive, (c) corrosive to flesh or metal, (d) readily burnable, with or without a flame, (e) transmits disease, or (f) radioactive. Some wastes cause only one problem; others combine several of the above

household hazardous waste: substances used in the home that have some or all of the characteristics of hazardous wastes and which should not be disposed of in the same manner as other solid waste

humus: organic material consisting of decayed vegetable matter that provides nutrients for plants and increases the ability of the soil to retain water

incinerate: to burn waste to ashes, reducing the volume of trash to be landfilled

incinerator: a plant designed to reduce the volume of waste by burning

inorganic: things not made from plant, animal, or carbon compounds; most inorganic compounds (e.g., glass or metal) are derived from mineral resources

landfill: a large outdoor site for the controlled burial of solid waste by spreading it in layers and covering it with soil. New regulations for landfills call for special engineering techniques to reduce hazards to public health and safety

leachate: liquid that has percolated through a landfill and/or been generated by the decomposition of solid waste and has dissolved or suspended materials in it such as decomposed waste or bacteria; must be collected and treated to avoid contamination of surface water or groundwater supplies

lime: a mineral or industrial form of calcium carbonate used in the production of glass, in pollution control devices in incinerators, and to control acidity in composts

litter: waste materials thoughtlessly discarded in an inappropriate place; littering is against the law in Massachusetts

manufacture: to make products from raw materials, especially on a large scale with machines

Materials Recycling Facility (MRF): a facility where recyclables are separated and processed for sale; the state's first MRF, serving the four western counties, opened in Springfield in January 1990

methane: a odorless, colorless but highly explosive (flammable) gas (CH_4) which is a by-product of solid waste decomposition; methane is also a commercial fuel, natural gas

microorganisms: microscopic living organisms involved in the sewage treatment process and in the composting of many other wastes

natural resources: valuable, naturally-occurring items such as plants, animals, minerals, water, and air which are used by people to help make things such as energy, food, clothes, buildings, etc.

nitrogen cycle: the continuous cyclic progression of chemical reactions in which atmospheric nitrogen is compounded, dissolved in rain, deposited in the soil, assimilated and metabolized by bacteria and plants, and returned to the atmosphere following decomposition

non-renewable resources: natural resources which, because of their scarcity, the length of time required to form them, or their rapid depletion, are considered finite in amount, such as petroleum, coal, natural gas, and copper

organic: derived from living organisms and containing carbon compounds; organic chemicals, those containing carbon, are also synthesized by humans

oxidation: chemical combination with oxygen, for example the rusting of iron

pH: a numerical measure of the acidity of a substance, ranging from very low pH values such as 3 (vinegar) through neutral (7) to high values like 10 (lye) which represent an extremely basic pH

packaging: the wrappings, container, or sealing used to protect, identify, and advertise a product

pesticide: any substance designed to kill living organisms, including insects (insecticides), plants (herbicides), fungi (fungicides), rats and mice (rodenticides), and bacteria (germicides)

plastic: any one of many human-made materials consisting of carbon in combination with hydrogen, oxygen, nitrogen, and other organic and inorganic elements which are produced by polymerization, and which can be molded, extruded, or cast into various shapes and films

pollution: harmful substances deposited in the air, water, or on land, leading to contamination of the environment

polyethylene: a common plastic used to make plastic bags and milk bottles

pulp: a soft, moist, sticky mass of fibers made up of wood, straw, etc., and used to make paper and paperboard

recycling: to use something over again; the collection and reprocessing of a manufactured material or waste product for reuse either in the same form or in the manufacture of the same or a different item

recycling center: a site where manufactured materials are collected and sold for reprocessing

refuse: a general term for solid waste materials, or trash

renewable resource: a natural resource derived from an endless or cyclical source (e.g., sun, wind, wood, fish); with proper management and wise use, replacement of these resources by natural or human-assisted systems can be approximately equal to their consumption

resource: a supply of something that can be used or drawn upon; something that can be used to make something else--wood into paper, bauxite ore into aluminum, old bottles into new ones, sand into glass, etc.

resource recovery: use of high technology to burn mixed solid waste and produce energy; may involve mechanical separation of recyclables before or after burning

reuse: to extend the life of an item by repairing or modifying it, or by creating new uses for it

sanitary landfill: see landfill

septic tank: a tank into which sewage is discharged and decomposed by bacteria

sewage: mostly liquid waste, including human waste, which is transported away by sewers and purified in a sewage treatment plant

sludge: the muddy sediment left after sewage has been processed

solid waste: all solid and semi-solid wastes, including garbage, rubbish, ashes, industrial wastes, demolition and construction debris, and household discards (appliances, furniture, equipment).

solid waste management: the controlling, handling, and disposal of all solid waste; one goal is to reduce waste to a minimum.

source reduction: behavior to deliberately reduce waste through educated consumer choices and disposal; the primary focus of the Massachusetts Solid Waste Management Action Plan developed by DEP.

styrofoam: a rigid polystyrene plastic that uses petroleum as a resource base.

tipping fee: charge to deposit waste in a landfill

transfer station: location run by a town or city to collect solid waste, which is then taken elsewhere (for example, a distant landfill)

trash: material considered worthless, unnecessary, or offensive that is usually thrown away; generally defined as dry waste material, excluding food waste (garbage) and ash (This term is often used interchangeably with the word, "garbage.")

waste: anything which is discarded or not considered useful

wastewater: water that has been used, either to manufacture a product or in the home, and which requires treatment and purification before it can be used again

white goods: household appliances, including ovens refrigerators, freezers, water heaters, washers, dryers, etc.

RESOURCES

A. MASSACHUSETTS RESOURCES

STATE GOVERNMENT AGENCIES

Executive Office of Environmental Affairs
100 Cambridge Street   Boston, MA 02202   (617) 727-9800
Secretary: John DeVillars

Department of Environmental Protection
One Winter Street   Boston, MA 02108   (617) 292-5500
Commissioner: Daniel S. Greenbaum

Department of Environmental Management
100 Cambridge Street   Boston, MA 02202   (617) 727-3163
Commissioner: Richard E. Kendall

Massachusetts Water Resources Authority
100 First Avenue   Charlestown Navy Yard   Boston, MA 02129   (617) 242-6000
Director: Paul F. Levy

Metropolitan District Commission
26 Somerset Street   Boston, MA 02108   (617) 727-5215
Commissioner: M. Ilyas Bhatti

Department of Fisheries, Wildlife, and Environmental Law Enforcement
100 Cambridge Street   Boston, MA 02202   (617) 727-1614
Commissioner: Walter E. Bickford

Department of Food and Agriculture
100 Cambridge Street   Boston, MA 02202   (617) 727-3002
Commissioner: August Schumacher, Jr.

State Office, Cooperative Extension
Stockbridge Hall   University of Massachusetts   Amherst, MA 01003   (413) 545-2715
State Office has listing of local Extension offices.

REGIONAL PLANNING AGENCIES

Regional planning agencies are public agencies that provide municipalities technical assistance in the areas of solid waste management, water resource protection, transportation planning, and affordable housing.

Berkshire County Regional Planning Commission
10 Fenn Street   Pittsfield, MA 01201   (413) 442-1521

Cape Cod Planning and Economic Development Commission
First District Court House   Barnstable, MA 02630   (508) 362-2511

Central Massachusetts Regional Planning District Commission
340 Main Street/Suite 747   Worcester, MA 01608   (508) 756-7717

Franklin County Commission
District Courthouse   425 Main Street   Greenfield, MA 01301   (413) 774-4015

Martha's Vineyard Commission
P.O. Box 1447   Oak Bluffs, MA 02557   (508) 693-3453

Merrimack Valley Planning Commission
350 Main Street   Haverill, MA 01830   (508) 374-0519

Metropolitan Area Planning Council
110 Tremont Street   Boston, MA 01208   (617) 451-2770

Montachusett Regional Planning Commission
R1427 Water Street   Fitchburg, MA 01420   (508) 345-7376

Nantucket Planning and Economic Development Commission
4 North Waste Street   Nantucket, MA 02554   (508) 228-7233

Northern Middlesex Area Commission
35 Market Street/2nd Floor   Lowell, MA 01852   (508) 454-8021

Old Colony Planning Council
47 West Elm Street   Brockton, MA 02401   (508) 583-1833

Pioneer Valley Planning Commission
26 Central Street   West Springfield, MA 01089   (413) 781-6045

Southeastern Regional Planning and Economic Development District
88 Broadway   Taunton, MA 02780   (508) 824-1367

REGIONAL REFUSE DISPOSAL DISTRICTS

Regional public entities authorized by state legislation to manage solid waste services and facilities for groups of two or more municipalities.

Greater Bedford Regional Refuse Management District
Olympia Building 888 Purchase St. New Bedford, MA 02740 (508) 993-2604

Carver-Marion-Wareham Regional Refuse District
Town Hall P.O. Box 99 Marion, MA 02738 (617) 748-2500

Martha's Vineyard Regional Refuse Disposal District
P.O. Box 2248 Oak Bluff, MA 02557 (508) 693-3479

Franklin County Solid Waste Management District
Commissioner's Office 425 Main Street Greenfield, MA 01301 (413) 774-4015

Northern Berkshire Solid Waste Management District
Town Offices Adams, MA 01220 (413) 743-1561

ENVIRONMENTAL GROUPS

Center for Ecological Technology (CET)
147 Tyler Street Pittsfield, MA 01201 (413) 445-4556
Independent non-profit organization providing western Massachusetts with services and information on energy conservation and solid waste management.

Clean Water Action
186 South Street Boston, MA 02111 (617) 423-4661
Administers the Environmental Shoppers Campaign which encourages shoppers and supermarkets to join in efforts to reduce packaging, promote recycling, and halt pesticide contamination of food.

Earthworm, Inc.
186 South Street Boston, MA 02111 (617) 426-7344
Non-profit, collectively-managed recycling organization providing collection (paper only), referral, and educational services to its clients and to the greater Metropolitan Boston community.

Eastern Massachusetts Recycling Coalition (EMRC)
P.O. Box 12 Bedford, MA 01730 (617) 275-0637
Organization of municipal recycling associations providing information, educational materials, and technical assistance to its members.

Environmental Lobby of Massachusetts
3 Joy Street Boston, MA 02108 (617) 742-2253
Privately funded, non-profit, exclusively devoted to promoting sound environmental laws in Massachusetts through lobbyists at the State House and statewide grassroots support.

Fundamental Action to Conserve Energy (FACE)
75 Day Street Fitchburg, MA 01420 (508) 345-5385
Provides conservation materials and information on energy and recycling issues to the North Central region of Massachusetts.

Greenpeace/New England
139 Main Street Cambridge, MA 02142 (617) 542-7052
International organization dedicated to preserving the earth and its resources. Information available regarding hazardous and solid wastes.

Harvard Environmental Law Society
Auston 20 Harvard Law School Cambridge, MA 02138 (617) 495-3125
Law students research current environmental issues for the public.

League of Women Voters of Massachusetts
8 Winter Street Boston, MA 02108 (617) 357-8380
Promotes the informed and active participation of citizens in government.

Massachusetts Association of Conservation Commissions (MACC)
Lincoln-Filene Center Tufts University Medford, MA 02155 (617) 381-3457
A private non-profit service corporation whose members are the municipal Conservation Commissions of Massachusetts. MACC assists the Commissions in improving the quality of environmental decisionmaking in their communities through workshops, lobbying, and publications.

Massachusetts Association of Conservation Districts (MACD)
20 Maple Street Randolph, MA 02368 (617) 693-1162
MACD is the association of the Commonwealth's 16 local conservation districts, organized to coordinate federal, state, and local programs and initiatives for the conservation of soil, water, and related resources.

Massachusetts Audubon Society (MAS)
South Great Road Lincoln, MA 01773 (617) 259-9500
The oldest state Audubon Society, MAS owns and protects over 14,000 acres of sanctuary land, with 17 staffed nature centers and an active membership of 36,000 households. Through conservation, education, research, and advocacy, its overall goal is to preserve a quality environment that supports both people and wildlife.

Massachusetts Environmental Education Society
Thorton W. Burgess Society 6 Discovery Hill Road East Sandwich, MA 02537
A professional organization dedicated to the promotion and improvement of environmental education in Massachusetts.

Massachusetts Public Interest Research Group (MASSPIRG)
29 Temple Place Boston, MA 02108 (617) 292-4800
Non-profit, nonpartisan research and advocacy organization focusing on state-level consumer and environmental issues.

MASSRECYCLE: The Massachusetts Recycling Coalition
P.O. Box 3111 Worcester, MA 01613
Non-profit statewide recycling coalition dedicated to bringing together individuals, local and state governments, industry, and environmental groups for the purpose of promoting and facilitating waste reduction, reuse, and recycling. A member-operated organization, MASSRECYCLE serves as an informational clearinghouse and an educational resource for members who are working to reduce waste in their homes, communities, businesses, and in government.

Mass Trash Action Coalition
c/o Clean Water Action 186 South Street Boston, MA 02111 (617) 423-4661
Consumer advocacy organization focusing on solid waste issues.

Sierra Club -- New England Chapter
3 Joy Street Boston, MA 02108 (617) 227-5339
Provides public education on environmental concerns and lobbying for enactment and enforcement of protective legislation. Contact Boston office for list of Sierra Club groups throughout the state.

Tufts University Center for Environmental Management
Curtis Hall 474 Boston Avenue Medford, MA 02155 (617) 381-3486
Established in 1984 to conduct research on health effects and technology, to analyze policy and to develop educational programs in the fields of hazardous and solid wastes and toxic substances.

ENVIRONMENTAL EDUCATION CENTERS

The Boston Public Schools Recycle Center
P.O. Box 1003 Boston, MA 02205 (617) 282-2812
The Center offers high quality by-products donated by a network of industries free to teachers for classroom projects and provides teacher in-service training, discovery workshops for children, and direct technical assistance for educators. The Center also runs projects in Worcester and Lawrence.

Buck Hill Conservation Education Center
RR #1 Box 265 McCormick Road Spencer, MA 01562 (617) 885-2595
Dedicated to the teaching of good conservation practices for land, water, and forest management; oversees a ten-acre pond with self-interpretive trail and an environmental library.

Cape Cod Museum of Natural History
Drawer R Route 6A Brewster, MA 02631 (508) 896-3867
Non-profit corporation dedicated to increasing the awareness and appreciation of the Cape's unique natural environment by residents and visitors, and to conserving the region's natural resources; offers exhibits, workshops, and other educational programs.

Habitat Institute for the Environment
10 Juniper Road   Belmont, MA 02178   (617) 489-5050
Non-profit organization that manages a 30-acre sanctuary; offers environmental education programs for adults and children which utilize the land as a teaching resource, and runs outreach programs for schools.

Hitchcock Center for the Environment
525 South Pleasant Street   Amherst, MA 01002   (413) 256-6006
The goal of the Hitchcock Center is to foster greater awareness and understanding of the environment and to develop "environmentally-literate" citizens; offers programs for the public and local schools, art exhibits, several camps, and a resource center for teachers and naturalists.

Horizons for Youth
121 Lakeview Street   Sharon, MA 02067   (617) 828-7550
School programs providing comprehensive one-day field trips or two-to-five-day residential programs where elementary through high school students can study the natural environment through structured exploration of woods, fields, lakes, and wetlands.

Massachusetts Audubon Society's Wildlife Sanctuaries and Nature Centers
South Great Road   Lincoln, MA 01773   (617) 259-9500
Contact state headquarters for a list of the 17 staffed centers throughout the state.

South Shore Natural Science Center
PO Box 429   Jacobs Lane   Norwell, MA 02061   (617) 659-2559
Private, non-profit center focusing on environmental education, and the natural and cultural history of the region; offers interpretive walks and activities, pre-school and summer day camps, workshops, and exhibits.

Thompson Island Education Center, Inc.
Thompson Island   P.O. Box 127   Boston, MA 02127   (617) 328-3900
The Center promotes individual initiative, responsibility, teamwork, and urban survival skills, while teaching students about their community's environment. Provides educational services to schools and organizations that offer experience-based programs.

B. NATIONAL RESOURCES

FEDERAL GOVERNMENT AGENCIES

U.S. Environmental Protection Agency/Region I
John F. Kennedy Building Boston, MA 02203 (617) 565-3715
(Covers all six New England states)

REGIONAL GOVERNMENT-RELATED ORGANIZATIONS

New England Waste Management Officials Association (NEWMOA)
85 Merrimac Street Boston, MA 02114 (617) 367-8558
A non-profit, interstate government organization formed by the directors of state hazardous and solid waste programs in New England to provide a forum for the discussion of common issues and problems in the areas of solid and hazardous waste management, to provide coordination and information-sharing between groups addressing these issues, and to promote public awareness.

Northeast Recycling Council
270 Broadway New York, NY 10017 (212) 693-0400
Formed in September 1987 by northeastern state recycling officials to exchange information, to encourage recycling among states, and to take positions on waste reduction, reuse, and recycling.

Coalition of Northeast Governors
Hall of States 400 North Capital Street Suite 382 Washington, D.C.

INDUSTRY ASSOCIATIONS

The Aluminum Association
900 19th Street, NW Washington, D.C. 20006 (202) 862-5163
Offers public information and packaging programs. General publications are free. Contact the Association for list of publications and audio-visuals.

Aluminum Recycling Association
1000 16th Street, NW Suite 603 Washington, D.C. 20036 (202) 785-0951
Offers pamphlet on aluminum recycling.

American Iron and Steel Institute
1000 16th Street, NW Washington, D.C. 20036 (202) 452-7100
Presents information on the primary steel producing companies, which comprise 80 percent of U.S. producers of raw steel. Publications available on materials recovery from municipal waste and tin can recycling.

American Paper Institute
260 Madison Avenue New York, NY 10016 (212) 340-0600
Trade organization representing the pulp, paper, and paperboard industry. Offers audiovisuals and free pamphlets on paper recycling.

Anheuser-Busch Companies, Inc.
Government and External Affairs One Busch Place St. Louis, MO 63118-1852
(Container Recovery Corp.)
Publications available regarding nationwide litter reduction and recycling programs.

American Petroleum Institute
2101 L Street, NW Washington, D.C. 20037 (202) 682-8000
Trade association of oil industries. Publications available on recycling used motor oil.

Council on Plastics Packaging in the Environment
1275 K Street, NW Washington, D.C. 20005 (202) 371-5228
Formed by the Society of the Plastics Industry to focus on solid waste disposal alternatives for plastics.

Glass Packaging Institute
1133 20th Street, NW Suite 321 Washington, D.C. 20036 (202) 887-4850
Offers kit designed to teach about the benefits of recycling glass containers, newspapers, and aluminum cans. Includes teacher's guide, copycat pages, color poster, and mini-filmstrip.

Institute of Scrap Recycling Industries, Inc.
1627 K Street, NW Washington, D.C. 20006 (202) 466-4050
Represents the scrap metal industry in promoting and building recycling programs and markets, and solid waste management.

Keep America Beautiful
Mill River Plaza 9 West Broad Street Stamford, CT 06902 (203) 323-8987
A non-profit organization funded primarily by the beverage industry to promote voluntary recycling and anti-litter campaigns.

National Center for Resource Recovery, Inc.
1211 Connecticut Avenue, NW Washington, D.C. 20036
Publications available regarding waste management and resource recovery.

National Solid Wastes Management Association (NSWMA)
1730 Rhode Island Avenue, NW Suite 1000 Washington, D.C. 20036 (202) 659-4613
NSWMA serves as a lobbying, educational, and research forum for its 2,700 member firms which represent every aspect of the solid and hazardous waste management industry.

Society of the Plastics Industry, Inc. (SPI)
1275 K Street, NW Suite 400 Washington, D.C. 20005 (202) 371-5244
SPI represents 1,900 industrial plastics firms in the U.S. Offers information on plastics recycling.

ENVIRONMENTAL GROUPS

Environmental Action Coalition
625 Broadway (Bleeker/Houston) New York, NY 10012 (212) 677-1601
Resources available include a newsletter on solid waste issues and a curriculum guide.

Environmental Action
1525 New Hampshire Avenue, NW Washington, D.C. 20036 (202) 745-4879
Supports grassroots efforts on environmental safety and waste reduction, including recycling, degradable plastics, and packaging. Publications include a newsletter covering environmental issues and information on plastics packaging.

Environmental Defense Fund (EDF)
257 Park Avenue South New York, NY 10016 (212) 686-4191
Founded in 1967, EDF was one of the first environmental groups to use litigation to change environmental policy. The organization strives to propose viable solutions that balance both the protection of the environment and the economics of a given capital project. Resources available on recycling and combustion issues.

INFORM
381 Park Avenue South New York, NY 10016 (212) 689-4040
A non-profit research center that works to protect the environment by examining and addressing business practices that have a negative affect on natural resources. Involved in issues surrounding source reduction and waste stream composition. Offers information on resource recovery and waste management.

League of Women Voters
1730 M Street, NW Washington, D.C. 20036 (202) 429-1965
Publications include information on household hazardous waste, source separation, resource recovery, and waste reduction.

National Recycling Coalition
45 Rockefeller Plaza Room 2350 New York, NY 10111
Brings together business and community interests to promote nationwide plans for waste reduction and recycling programs. A newsletter and other information is available on reduction, reuse, and recycling.

The National Toxics Campaign (NTC)
29 Temple Place 5th floor Boston, MA 02111 (617) 482-1477
NTC is a coalition of citizens, scientists, consumer groups, and environmentalists formed to develop and implement solutions to the toxics crisis. Publications available on recycling.

National Wildlife Federation
1412 16th Street, NW   Washington, D.C. 20036   (202) 797-6800
Conservation organization working to restore and conserve the nation's resources. Information and activities for grades 4-12 in environmental issues.

The New Alchemy Institute
237 Hatchville Road   East Falmouth, MA 02536   (508) 564-6301
Offers information on composting.

Worldwatch Institute
1776 Massachusetts Avenue, NW   Washington, D.C. 20036   (202) 452-1999
Non-profit, independent organization for research and analysis of hazardous and solid waste management. Publications available regarding global resource issues.

C. CURRICULA AND ACTIVITY BOOKS

SOLID WASTE AND RECYCLING

The resources listed below include grade levels if indicated in the original source.

Association of Vermont Recyclers Teacher's Resource Guide for Solid Waste and Recycling Education. Contact: Susan Pedicord, Association of Vermont Recyclers, 55 East Street, Montpelier, VT 05602; (802) 233-6009. (grades K-12; cost: $40.00 out-of-state)

Audio Visual Aids on Recycling. 1985. Contact: Bureau of Solid Waste Management, Department of Natural Resources, Box 7921, Madison, WI 53707.

A-Way With Waste, Washington State Department of Ecology. Contact: Jan Lingenfelter, Washington State Department of Ecology, 4350-150th Avenue, NE, Redmond, WA 98052; (206) 885-1900. Over eighty K-12 activities. (cost: approximately $12)

Bottle Biology Resources Network, Center for Biology Education, University of Wisconsin-Madison. Contact: Bottle Biology Resources Network, University of Wisconsin, 1630 Linden Drive, Madison, WI 53706; (608) 263-5645. Classroom-tested approach to hands-on biology using plastic beverage bottles and other throw-away containers to make apparatus for experiments and life science explorations. Activities include making compost columns, miniature ecosystems and greenhouses, aquariums, and spider and insect zoos. (grades K-12)

California State Environmental Education Guide. 1987. Contact: Alameda County Office of Education, Library Dept., 313 West Winton Avenue, Hayward, CA 94544-1198. Eight instructional units and six action projects. (grades K-6; cost: $17.95)

Cans For Education Curriculum Guide. New Hampshire Governor's Energy Office. Contact: NHRRA, Cans for Education, PO Box 721, Concord, NH, 03302-0721.

Channing L. Bete Company, publishers of Scriptographic Booklets. Contact: Channing L. Bete Company, 200 State Street, South Deerfield, MA 01373; (800) 628-7733. *What You Should Know About Recycling* (#48595) explains the concept of recycling, what materials can be recycled, and how programs work; *Let's Recycle: A Coloring and Activities Book* (#56648) includes pictures, puzzles, and other activities which tell children why recycling is important, what can be recycled, and how to prepare it.

Directory of Resources: An Educator's Guide to Solid Waste Management Education. 1987. Contact: Mary Kohrell, Midwest Recycling Coalition, Lincoln, NE.

Divide and Conquer: A Teacher's Guide to Waste Management. Contact: Ontario Ministry of the Environment. (grades 4-6)

Do It Yourself Guide To: A Solid Waste Seminar. 1977. Contact: Minnesota Regional Environmental Council, Quarry Hill Nature Center, Rochester, MN.

Don't Waste, Waste! Contact: Environmental Action Coalition, 625 Broadway (Bleeker/Houston), New York, NY 10012. (cost: approximately $3.50)

Education Programs in Resource Recovery. Contact: Michigan Department of Natural Resources, Lansing, MI. (grades K-12)

Florida Curriculum, Florida Department of Education, Bureau of Elementary & Secondary Schools, Knot Building, Tallahassee, FL 32399. Contact: Dr. Charles Sherwood, Division of Public Schools, (904) 487-1785 OR Dr. Wendy Cullar, Deputy Director, (904) 488-2601. (cost: free)

Garbage Reincarnation: Interdisciplinary Approach to Materials Conservation and Recycling. Contact: Sonoma County Community Recycling, P.O. Box 1375, Santa Rosa, CA 95402. (grades 4-6)

The Great Glass Caper. Contact: Pennsylvania Glass Recycling Corporation, 590 North Second Street, Harrisburg, PA 17101; (717) 234-8091. Educational kit on recycling with mini-film strip, poster and mimeograph activity pages and teacher's guide. (grades 4-6; cost: free)

Here Today, Here Tomorrow. 1984. Contact: New Jersey Department of Energy and Environmental Studies Center, Inc., Brown Mill, NJ. (grades 1-12)

The Importance of Being a Garbologist. Contact: Group for Recycling in Pennsylvania Box 4806, Pittsburgh, PA 15206. (grades 3-6)

Kansas City Recycling Teacher's Edition. Contact: Sandra Leigh Custard, Kansas City Department of Public Works, Mid-America Regional Council, 20 West 9th Street, Kansas City, MO 64105; (816) 474-4240.

Kids Gardening by Kevin Raftery and Kim Gilbert Raftery. Contact: Klutz Press, 2170 Staunton Court, Palo Alto, CA 94306. Growing activities for children who want to be gardeners, applicable for any season, any climate, indoors or out; includes step-by-step directions on making compost.

Let's Recycle: Lesson Suggestions for Teachers K-6 and 7-12 (Publication #SW-801). 1989. Contact: U.S. Environmental Protection Agency, Office of Water and Waste Management, Washington, D.C. 20460.

Looking Good in Ohio's Schools (Educator's Guides). 1982. Contact: Ohio Department of Natural Resources, Fountain Square, Columbus, OH. (grades K-3, 4-6, 7-12)

Ohio Science Workbook: Litter Prevention & Recycling. 1987. Contact: Ohio Academy of Science, Columbus, OH. Advanced science project ideas; good bibliography.

Oscar's Options. Rhode Island Department of Environmental Management, 1986, 1987. Contact: Carole Bell, DEM, 83 Park Street, Providence, RI 02903. (grades 4-8; cost: two volumes, $50 each)

Recycle. Contact: Stepping Stones, 10 Willow Avenue, Somerville, MA 02144. Activities and worksheets. (grades K-3, 4-6, 7-12)

Recycle Alaska. 1982. Contact: Alaska State Department of Environmental Conservation, P.O. Box F, Juneau, AK 99811.

Recycling: A Solution to Pollution. 1984. Contact: Lisa Raddke, Community Recycling Center, 720 North Market, Champaign, IL. (grades K-4; cost: $5.00)

Recycling: Activities for the Classroom by Mary Lynne Bowman and Herbert L. Coon. Contact: ERIC/SMEAC Center, Ohio State University, 1200 Chambers Road, Columbus, OH 43212.

Recyclum. Eco-Alliance, 1980. Contact: Resource Conservation Consultants, Portland, OR. (grades K-6)

Reduce, Reuse, Recycle: Handbook for School-wide Recycling Projects. Contact: Arizona Energy Office, State Capitol, 5th floor, 1700 West Washington, Phoenix, AZ 85007.

Reduction, Reuse, Recycling. Contact: Association of Oregon Recyclers, 1615 NW 23rd Avenue, Suite One, Portland, OR 97210. (grades K-12)

Re: Thinking Recycling. 1987. Contact: Alene Cordas, Department of Environmental Quality, Waste Reduction Section, 811 SW 6th, Portland, OR 97204. Activities and information on solid waste divided into five age levels. (grades K-12)

Rise Up Singing. 1988. Contact: Sing Out Corporation, PO Box 5253, Bethelem, PA 18015; (215) 865-5366. Song book which includes tunes about the environment with titles such as "Garbage," "Honor the Earth," and "We are All One Planet."

Science and Environmental Education Resource Guide. 1989. Contact: California State Department of Education, 721 Capital Mall, Sacramento, CA 95814. Directory of national science and environmental education resources.

Solid Waste/Energy Curriculum. 1982. Contact: The Conservation & Environmental Studies Center, Inc., 120-13 Whitesbog Road, Brown Mills, NJ. Activity ideas, curriculum guide, teacher briefs. (grades K-12)

Super Saver Investigators. 1988. Contact: Ohio Department of Natural Resources, Office of Litter Prevention, Fountain Square, Building F, Columbus, OH 43224; (614) 265-6444.

Teacher's Guide: Educational Material in Resource Recovery. 1984. Contact: Cathy Berg Moeger, Minnesota Pollution Control Agency, St. Paul, MN. (grades K-12)

Teaching Science with Garbage: An Interdisciplinary Approach to Environmental Education from the Point of View of Science, Mathematics and Social Studies by Vivian and Albert Schatz. 1971. Contact: Rodale Press, Emmaus, PA. (grades 4-8)

The Trash Monster and *The Wizard of Waste* Education Programs, California Waste Management Board, Sacramento, CA, 1980. Contact: California State Department of Education, P.O. Box 271, Sacramento, CA 95802. Includes filmstrip and tape, poster, stickers, teacher's guide, and student workbooks. (grades 2-6; cost: approximately $25)

Waste: A Hidden Resource. Contact: Tennessee Valley Authority, Citizen Action Office, 400 West Summit Hill Drive, Knoxville, TN 37902. Solid waste management and recycling curriculum guide prepared by junior and high school teachers.

Waste in Place. 1963. Contact: Keep America Beautiful, Inc., Stamford, CT.

WISE: Waste Information Series in Education. 1989. Contact: Marta Fisher, Michigan Department of Natural Resources, Stevens T. Mason Building, Box 30028, Lansing, MI 48909; (517) 373-0540. (grades K-12; cost: free while supplies last)

Wisconsin Recycling Study Guide. 1988. Contact: John Reindi, Wisconsin Department of Natural Resources, Madison, WI. (grades 4-12)

HOUSEHOLD HAZARDOUS WASTE

Chemical Education for Public Understanding Project (CEPUP). Contact: Dr. Herbert D. Their, Lawrence Hall of Science, University of California, Berkeley, CA 94720; (415) 642-8718. Activity-oriented science modules. (grades 7-12)

Bags, Beakers and Barrels. 1986. Industrial States Policy Center and the School of Natural Resources, University of Michigan. Contact: Sue Lacey, Ohio Public Interest Campaign, 1501 Euclid Avenue #599, Cleveland, OH 44115; (216) 861-5200 or the Industrial States Policy Center, 1406 W. 6th Street, Cleveland, OH 44113. (cost: $15)

The Dilemma of Toxic Materials: Classroom-tested Ideas and Resources for Social Studies and Science Teachers by Gerald C. Llewellyn, Martin A. Tarter and Marijean Hawthorne. 1985. Contact: School of Education, Virginia Commonwealth University, Richmond, VA 23284.

Household Hazardous Waste Wheel. 1988. Contact: Environmental Hazards Management Institute, P.O. Box 832, 10 Newmarket Road, Durham, NY 03824; (603) 868-1496. An easy-to-use guide to hazardous goods around the house, automobile, and yard; lists hazardous ingredients, hazardous properties, suggested disposal methods and alternatives for 36 chemical products. (cost: $2.75/each for quantities less than 100; discounts available for larger orders)

Hazardous Waste Education Kit. Contact: Ontario Federation of Naturalists, 355 Lesmill Road, Don Mills, Ontario M3B 2W8. A resource kit for high school students including an assortment of informational pamphlets and lesson plans. (cost: $45, plus $5 p/h)

Household Toxics: A New Curriculum for Grades 4-6. Contact: The Environmental Health Coalition, 1844 Third Avenue, San Diego, California 92101; (619) 235-0281. An easy-to-use science and health curriculum designed to fit into a busy classroom schedule. Includes 11-minute videotape, "Outta Sight, Outta Mind," six lesson plans (two for each grade level), learning activities, lab demos, and a board game, "The House of Hazards." Topics include what's toxic, warning labels, routes of exposure, safety rules, health effects, environmental concerns, and safer alternatives. Full set of black line masters and informative reference materials. Field-tested in San Diego County Schools. (cost: $39.50; specify VHS or Beta for video)

Sleuth: Educational Activities on the Disposal of Household Hazardous Waste (Report #10) by Claire Dyckman *et al.* 1982. Contact: Metro Toxicant Program, Water Quality Division, Seattle, WA.

School Science Laboratories: A Guide to Some Hazardous Waste Substances, Council of State Science Supervisors. 1984. Contact: Ken Giles, U.S. Consumer Product Safety Commission, 5401 Westward Avenue, Bethesda, MD; (301) 492-6580. Supplements the National Institute on Occupational Safety and Health's (NIOSH) Manual of Safety and Health Hazards in the School Science Laboratory. Identifies certain potentially hazardous substances in use in many labs and provides a concise inventory to enable science instructors to take the initiative in providing for proper storage, handling, use, and removal of extremely hazardous materials. Provides lists of explosives, carcinogens, highly toxic, and/or corrosive or irritant chemicals. (cost: free)

Teaching about Hazardous and Toxic Materials by John F. Designer and Marylin Lisowski. Contact: ERIC/SMEAC, The Ohio State University, 1200 Chambers Road, Columbus, OH 43212. A compilation of activities and lesson plans from ERIC Clearinghouse for Science, Mathematics, and Environmental Education, divided into K-3, 4-6, 7-9, and 10-12. (cost: $12.50)

Toxics in My Home? You Bet! Learning Activities On Household Toxics.
Contact: Golden Empire Health Planning Center, 2100 21st Street, Sacramento, CA 95818; (916) 731-5050. (grades K-12)

Toxics Taking Charge. Contact: Alameda County Office of Education, 313 West Winton Avenue, Hayward, CA 94554-1198. Supplement to the California State Environmental Education Guide. (grades 4-6)

SOLID WASTE MANAGEMENT JOURNALS

BioCycle: The Journal of Waste Recycling JG Press, Inc., Box 351, Emmaus, PA 18049; (215) 967-4135. (cost: $46 per year, $78 for two years, published 10 times per year)

Garbage Magazine: The Practical Journal for the Environment 435 Ninth St., Brooklyn, NY 11215; (718) 788-1700. (cost: $29 per year, published 6 times per year.)

Recycling Today GIE Publishers, 4012 Bridge Avenue, Cleveland, OH 44113. (cost: $22 per year, published monthly)

Resource Recycling: North America's Recycling Journal P.O. Box 10540, Portland, OR 97210; (503) 227-1319. (cost: $27 per year, published 7 times per year)

Waste Age 1730 Rhode Island Ave., NW, Suite 1000, Washington, D.C. 20036; (202) 861-0708. (cost: $40 per year, published monthly)

C. AUDIO-VISUAL RESOURCES

SOLID WASTE AND RECYCLING

Alu Man The Can. 1987. Contact: Ricki Kashdan, Public Education and Risk Communication Division, Environmental and Occupational Health Science Institute, UMDNJ-Robert Wood Johnson Medical School, Trailer #2, 675 Hoes Lane, Piscataway, NJ 08854-5635; (201) 463-4500. Animated. (grades K-3; cost: 1/2" VHS--$25, 3/4"--$35)

Aluminum: An Element of Change. 1978. 21 minutes; 16mm. Contact: The Aluminum Association, 900 19th Street, NW, Washington, D.C. 20006; (202) 862-5163. Sound cycles. (cost: free loan)

Aluminum Recycling: Your Next Assignment. VHS. Contact: The Aluminum Association, 900 19th Street, NW, Washington, D.C. 20006; (202) 862-5163. (cost: free loan)

Bullfrog Films, Inc. Contact: Bullfrog Films, Oley, PA 19547. Rents films and videos with environmental themes.

Buy Recycled Products - They're Worth Our Environment. 10 minutes; 47 slides with cassette. Contact: Michigan Department of Natural Resources, Waste Management Division, Resource Recovery Section, Lansing, MI 48909; (517) 373-0540. Promotes purchase of Michigan recycled products. Includes reasons to buy goods manufactured from recycled materials, and users of re-refined motor oil, plastic, lumber, retreated tires, shredded newsprint products, recycled paperboard, and recycled printing papers. (cost: free 10-day loan)

Choices. Adelphi Productions. 14 minutes; 1/2" VHS. Contact: Michigan Department of Natural Resources, Waste Management Division, Resource Recovery Section, Lansing, MI 48909; (517) 373-0540. Features the residents of a community that made a choice to replace an overflowing landfill with a resource recovery facility to dispose of their waste and convert it to energy. (cost: free 10-day loan)

Closing the Loop. 1980. 10 minutes. Contact: California Waste Management Board. Color filmstrip with tape.

Corporation for Public Broadcasting 1990 -- Year of the Environment-Environmental Resource Compendium. Contact: PBS, Elementary and Secondary Service, 1320 Braddock Place, Alexandria, VA 22314; (202) 955-5110. (cost: $10)

Cycles. 1972. Glass Container Manufacturing Institute. 14 minute; 16 mm. Contact: Environmental Action Coalition, 625 Broadway, New York, NY 10012; (212) 667-1601.

Energy Where You Least Expect It. 1982. 28 minutes; color. Producer and Distributer: Third Eye Films. Large and small waste-to-energy projects including incineration, methane recovery, refuse-derived fuel, recycling. Addresses the issues of financing, plant efficiency, air pollution, and energy distribution. Also available from the Wisconsin Department of Natural Resources.

Forest Murmurs. 9 minutes. Contact: Perennial Education, Northfield, IL. Reminds the viewer of his/her responsibility for litter, showing a place of great beauty being ruined by carelessness. (grades K-3)

Garbage. 1970. 11 minutes; 16 mm, color. (#1-9466) Contact: Syracuse University Film Rental Center, 1455 East Colvin Street, Syracuse, NY 13244-5150; (800) 223-2409. Shows fanatically neat people juxtaposed with those totally indifferent. Illustrates disposal systems struggling to keep up with an ever-increasing flow of garbage created by our affluent society. (cost: $12 rental)

Garbage Explosion. 1970. 16 minutes; 16 mm, color. (#2-8130) Contact: Syracuse University Film Rental Center, 1455 East Colvin Street, Syracuse, NY 13244-5150; (800) 223-2409. Investigates the nature, volume and composition of solid waste, which includes a growing proportion of less destructible paper, metal, plastic and glass. Presents advantages of current disposal methods and shows possible long-range solutions. From "Ecology and Environmental Science" series. (cost: $12 rental)

The Garbage Monster. Contact: Environmental Action Coalition, 625 Broadway, New York, NY 10012. Slides with script.

Help Woody Spread the Word. 18 minutes. Contact: Animedia, Inc., Los Angeles, CA. Helps children recognize pollution problems and their solutions; enjoyable musical format. (grades K-6)

The House That Recycling Built. 1973. 10 minutes; 16mm. (#112) Contact: The Reynolds Metal Company, Richmond, VA. (grades 4-6)

Junk Ecology. Contact: Troll Associates. Filmstrips with cassettes. Step-by-step guide for converting household trash items into practical for decorative items. Grades 3-6: Set 1--Recycling Paper and Cardboard, Recycling Wood Sticks; Set 2--Recycling Plastic Throw Away, Recycling Tin Cans and Bottles Caps; Set 3--Recycling Jars and Bottles, (cost: $41.50)

In The Bag. Contact: Walt Disney Productions, Burbank, CA. Features Humphrey the Bear and his problems in cleaning up a littered park.

Industry Recycles. 1980. 10 minutes. Contact: California Solid Waste Management Board. Color filmstrip and tape. (grades 7-12)

Leaf Composting. 30 minutes; VHS. Contact: Michigan Department of Natural Resources, Waste Management Division, Resource Recovery Section, Lansing, MI 48909; (517) 373-0540. Narrated by a backyard gardener discussing principles of composting as well as construction of a compost pile and uses of compost. (cost: free 10-day loan)

Let's Help Recycle. 1973. 11 minutes. Contact: ACI Media, Inc., New York, NY. Students present solutions for recycling problems to their city council as an illustration of what children can do about recycling wastes. Encourages source reduction; shows students preparing materials for recycling. (grades K-3)

Light at the End of the Pipe, Argonne National Lab. 1979. Contact: Michigan Department of Natural Resources, Waste Management Division, Resource Recovery Section, Lansing, MI 48909; (517) 373-0540. Methane recovery. (cost: free 10-day loan)

Media Network. Contact: Media Network, 121 Fulton, 5th floor, New York, NY 10038; (212) 619-3455. Environmental education films and videos. Also distributes *Greenjeans* guide listing available environmental films and videos. (cost: $6.50 for individuals; $9.50 for institutions)

Meecology. 26 minutes. Contact: Peshak Films, Lake Forest, IL. Portrays children from varied surroundings (rural, urban, suburban, and inner city) showing how each child relates to his environment; for use with McDonald's Ecology Action Park. (grades K-3)

The Mountain in the City: New York's material use and disposal crisis. 52 minutes; VHS format. (#313). Produced by the New York State Legislative Commission on Solid Waste Management. Contact: Michigan Department of Natural Resources, Waste Management Division, Resource Recovery Section, Lansing, MI 48909; (517) 373-0540. (grades: high school to adult; cost: free 10-day loan)

The Neatos and the Litterbugs in the Mystery of the Missing Ticket. 1974. 6 minutes; 16 mm., color. Contact: Sandles Institutional Films, Inc., Racine, WI.

The Need to Know. 1982. 28 minutes; 16 mm. Contact: Dow Chemical Company. Chemical manufacturing and waste disposal.

Organic Gardening: Composting. Rodale Press. 11 minutes. Contact: Building Films, Oley, PA 19547; (800) 543-FROG. Using live action and animation, the film shows how to build a compost heap, what ingredients to use and in what proportions, how to layer the heap to ensure speedy and uniform decomposition, and what kinds of containers to use. (cost: 16 mm-$25; video $60 purchase or $20 rental)

Plastics Recycling Pilot Plant: A Video Tour. 6 minutes. Contact: Plastics Recycling Foundation, 1275 K Street, NW, Washington, DC 20005; (202) 371-5200. Tour of Rutger's Center for Plastics Recycling Research. (cost: $10 or free loan)

Recyclemania. Contact: Do Dream Music, P.O. Box 5623, Takoma Park, MD 20912. A cassette tape of music on recycling by Billy B., a nationally established children's musician and performer; appropriate for upper elementary students. (cost: $7)

Recycling. 1971. 20 minutes. Contact: Midwest Regional Library, Berlin, VT. (grades 7-12)

Recycling: A Way of Life. 1980. Aluminum Association. 15 minutes; 16mm or VHS. Contact: Modern Talking Pictures Service, 5000 Park Street North, St. Petersburg, FL 33709; (813) 541-5763. Footage of aluminum recycling process (grades 7-12; cost free loan)

Recycling in Action. 1973. 14 minutes, color. (#2-10563) Contact: Syracuse University Film Rental Center, 1455 East Colvin Street, Syracuse, NY 13244-5150; (800) 223-2409. Establishes the need for recycling and then makes a general introduction to community-type volunteer reclamation centers, showing preparation of recyclables for market. (cost: $12 rental)

Recycling, The Need Is Clear. 12 minutes. Contact: Glass Packaging Institute, 1133 20th Street, NW, Washington, D.C. 20036; (202) 887-4850. Describes glass recycling programs nationwide.

Recycling: Waste into Wealth. 29 minutes; 1/2" VHS. Contact: Bullfrog Films, Oley, PA 19547; (800) 543-FROG. Shows how to prepare materials, curbside collection, drop-off centers, processing of materials, etc.; study guide and resource guide accompany film. (grades 5 to adult; cost: sale $450 16mm or $175 video; rental $55)

The Rotten Truth, produced by the children's educational program "3-2-1 Contact." Contact: KQED, Booksales/The Rotten Truth, 5959 Triumph Street, Commerce, CA 90040; (800) 441-3000. Excellent presentation by children of information on waste disposal; relevant to both children and adults. (cost: $14.95, plus $3 p/h)

Rubbish to Riches. 1979. 11 minutes; 16mm, color. Lindenmeyer Films. Contact: Energy Information Center, Vernon, VT. Waste products, instead of being dumped, can be separated into burnable materials and reclaimed iron, steel and aluminum. This film shows some of the ways waste products can be converted into fuel and trash can be recycled into these usable products. (grades 7-12)

Sesame Street, Volume III. People In Your Neighborhood; Somebody Come and Play; Going for a Ride; Trash. Contact: Troll Associates. (grades K-3)

The Soiled Frontier. State of Oregon Environmental Report, Oregon Division of Continuing Education. 1973. 27 minutes. Air, water, solid waste pollution problems in Oregon. Auto exhaust, oil, tires, junk cars, litter, bottle bill, estuary landfill, personal commitment, small actions count, shows successful clean-ups, etc.

Solid Waste Management. Bethel/Royalton Solid Waste Committee's video production by Stu MacGowan and the 7th and 8th grades from South Royalton and Witcomb High Schools. Contact: Stu MacGowan, c/o Union Video, 1 Main Street, Burlington, VT. (802) 863-1046. (grades 4-12; cost $22.50 ppd)

Space Station: EARTH. Contact: David M. Polis, Solid Waste Management Division, Snohomish County Public Works, 4th Floor, County Administration Building, Everett, WA 98201; (206) 259-9425. Recycling video program. (grades: 4-5; cost: $40)

Technology and Trash. Produced by Caterpillar. 16mm and VHS. Contact: Modern Talking Picture Service, 5000 Park Street North, St. Petersburg, FL 33709; (813) 541-5763. Describes how landfills work. (grades 7-8, 9-12; cost: free loan)

Toxic Chemicals: Information is the Best Defense. League of Women Voters of California. Contact: Bullfrog Films, Oley, PA 19547; (800) 543-FROG. Part I. Who Needs to Know? Part II: Developing a Community Right-to-Know Law.

The Trash Monster. 12 minutes. Contact: California Waste Management Board, 1020 9th Street, Suite 300, Sacramento, CA 95814. Part of the Trash Monster Education Kit. (grades K-6)

Virginia Tire Fire. U.S. Coast Guard. 13 minutes; 1/2" VHS. Contact: Michigan Department of Natural Resources, Waste Management Division, Resource Recovery Section, Lansing, MI 48909; (517) 373-0540. Illustrates the extensive fire hazard associated with discarded tire stockpiles and U.S. Coast Guard efforts to control a serious tire fire in Virginia. (cost: free 10-day loan)

Waste. by Lynn Corcoran. 1985. 29 minutes. Contact: Bullfrog Films, Oley, PA 19547; (800) 543-FROG. Connects consumer habits, from the individual to the multinational, with the waste problem. Views common and uncommon examples of the generation, disposal, and reuse of a variety of waste including toxics, municipal sewage, space waste. (grades 7-adult; cost: $150 purchase; $50 rental)

Waste to Energy. Produced by the University of Wisconsin. 22 minutes; 1/2" VHS. Contact: Michigan Department of Natural Resources, Waste Management Division, Resource Recovery Section, Lansing, MI 48909; (517) 373-0540. Part I: Questions to Consider, and Part II: Planning the Project. (cost: free 10-day loan)

Waste to Energy. 1980. 10 minutes. Contact: California Solid Waste Management Board, 1020 9th Street, Sacramento, CA 95814. Color filmstrip and cassettes.

Wizards of Waste. 12 minutes. Contact: California Solid Waste Management Board, 1020 9th Street, Sacramento, CA 95814. (grades K-3)

Woodsy Waste Wise (K-6) and *Waste Wise* (7-12, adult). Contact: Rich Grey, Cornell Media Services, Audio Visual Resources Center, Building 8, Research Park, Ithaca, NY 14850; (607) 255-2091. Slides, tape and scrip, with activities. (cost: $14 rental; $39 and $47 purchase, respectively)

The following videos are available from Roger Bailey, Video-Active Productions, Box 322, Route 2, Canton, NY 13617; (315) 386-8797.

W.O.W. 1: Auburn, ME Incinerator, 20 minutes. Describes general problems with incineration and discusses merits of the alternatives.

W.O.W. 2: Rome, NY Incinerator, 30 minutes. Covers citizen concerns about the plant and some of the mechanical problems in the first year of operation.

W.O.W. 4: Interview with Bernd Franke, 22 minutes. Describes a study by the Institute for Energy and Environmental Research in Heidelburg, Germany which compared nine different methods of handling waste and found that by far the best method was a combination of mandatory source separation, composting, and recycling.

W.O.W. 5: Windham, CT Incinerator, 60 minutes. Tour of plant and interviews with concerned local residents.

W.O.W. 6: Recycling in Germany, 60 minutes. Shows source separation programs, a separation plant for mixed recyclables, a factory recycling mixed plastics, an in-vessel composting plant, drop-off recycling containers and toxic removal efforts.

W.O.W. 7: Recycling in the USA: Don't Take "No" For An Answer, 60 minutes. Focuses on four individuals: 1. Joe Garbarino, a waste hauler from Martin County, CA; 2. Peter Karter, an engineer from Connecticut; 3. Mark Lohbauer, a lawyer and council member from Pennshauken, NJ: and 4. David Birbeck, the second selectman from Stonington, CT. Each is associated with a successful recycling program and each has been unwilling to be discouraged by pessimists.

W.O.W. 8: Skamania County, Washington: Materials Recovery Facility, 47 minutes. Located in rural Skamania County (population 10,000) this family can handle the complete waste stream and has reduced the volume of materials going to the landfill by 60 to 65 percent.

W.O.W. 9: Joe Garbarino: The Only Way to Go. The Martin County, CA Materials Recovery Plant, 33 minutes. Joe Garbarino talks about the past, present and future aspects of the garbage programs he successfully operates.

W.O.W 10: Millie Zantow: Recycling Pioneer, 48 minutes. Features Millie Zantow from North Freedom, Wisconsin. Millie's energy and vision is behind this successful operation which utilizes part time and volunteer work.

W.O.W 11: Zoo Doo and You Can Too, 59 minutes. Begins with the composting programs at the Woodland Park Zoo Seattle, WA, and presents a low tech approach to compost animal manure, food waste and yard waste. A "Home Composting" set up, oriented toward children is also featured. The second part of this tape shows many different methods of composing.

HOUSEHOLD HAZARDOUS WASTE

Beginning at Home: Tackling Household Hazardous Waste. 1986. 18 minutes; VHS, Beta or 3/4" cable. Contact: The League of Women Voters of Massachusetts, 8 Winter Street, Boston, MA 02108; (617) 357-8380. (cost: $75, $30 non-profit; rental $25, $10 non-profit; make checks payable to "Scharfman Fund, LWVM")

Household Hazardous Waste: Everyone's Problem. 19 minutes. Contact: The League of Women Voters of Massachusetts, 8 Winter Street, Boston, MA 02108; (617) 357-8380. Six week notice for rental; make checks payable to: "Scharfman Fund, LWVM." (cost: $100, $65 non-profit; 10-day rental $25, $15 non-profit)

The following audio-visual aids are available from The Environmental Health Coalition, 1844 Third Avenue, San Diego, CA, 92101; (619) 235-0281.

Outta Sight, Outta Mind. 1988. 11 minutes. Made for children (ages 8-12), this program focuses on the health effects of household hazardous materials and pollution due to improper disposal. A boy and his grandfather visit a polluted lake closed to fishing and discuss what's toxic, how toxins enter the body, safer substitutes, and recycling waste oil. Safe use, storage, and disposal of household hazardous materials are also covered.

Safer Pets Control (for Amateur Exterminators). 1988. 30 minutes. What can you do to control insects without toxic pesticides? Environmentalist Sharon Taylor demonstrates practical (and sometimes comical) methods to control five common indoor pests. Organic gardening experts explain keys to preventing insects and weeds in the garden.

Safe Substitutes. 15 minutes. 120 slides/carousel/audio tape. Environmental Health Coalition has identified safer products and techniques for cleaning your home and controlling pests. This slide show presents practical information to use for safer home management.

Toxics in the Home. 1985. 29 minutes. Presents the use, storage and disposal dilemmas related to household toxic materials. Health and hazardous materials professionals identify problems and suggest solutions. Common household products are featured and their hazards examined.

RELATED ENVIRONMENTAL AND ENERGY CONSERVATION FILMS

America's Wetlands. 28 minutes; 16mm. Contact: Vermont Department of Fish and Wildlife. Exploration of America's wetlands, their role as wildlife habitat, and the necessity to protect these valuables ecosystems. (cost: free loan)

The Lorax. by Dr. Seuss. Contact: Office of Public Affairs, US EPA, Region 1, JFK Federal Building, Boston, MA 02203; (617) 565-3187.

Nature's Way. 13 minutes; 16mm. Contact: Vermont Department of Fish and Wildlife. Life on a small pond from microorganisms to man. (grades K-6; cost: free loan)

Pigopolis. 1980. 12 minutes; 16mm. Industrial Media. Contact: Energy Information Center, Vernon, VT. Animated illustration of energy resources, conservation, and wise energy use. A city of pigs uses energy in excess to the point of endangering themselves. Includes teacher's activity guide. (grades K-6; cost: free loan)

Toast. 1974. 12 minutes; 16mm. Earth Chronicles. Contact: Energy Information Center, Vernon, VT. Images set to music illustrating the energy-intensive preparation and marketing of food. (cost: free loan)

ENTERTAINERS

Edgecomb, Diane: Widerwalks Storytelling
233 Wood Avenue, Hyde Park, MA 02136

Elfin Puppet Theater: Puppetry and Music Performances
Sarah Elston, P.O. Box 362, Williamsburg, MA 01096 or
Roger Tincknell, P.O. Box 332, Montague, MA 01351

Golden, Jack: mime suitable for all ages
528 Leyden Road, Greenfield, MA 01301

Herson, Barbara: Earthtunes--combination of music and environmental education
16 Linder Terrace, Newton, MA 02158

McClure, Glenn: public presentations on "Garbage"
P.O. Box 293, Genesco, NY 14455

Seidman, Evi: stand-up environmentalist
2 Everett Street, Jamaica Plain, MA 02130

Wenk, Timothy: The Magic of Recycling. (grades K-4)
P.O. Box 500, Stockbridge, MA 01262 (413) 243-0629

E. FURTHER READINGS

FOR EDUCATORS
(Also check materials listed in the Bibliography section of the Appendices)

Abelson, Philip H. "Municipal Waste--Editorial." *Science.* Vol. 236, No. 4807 June 12, 1987, p. 1409.

Beck, Melina, *et. al.* "Buried Alive," *Newsweek.* November 27, 1989, pp. 67-76.

Begley, Sharon, Ginny Carroll, and Tim Padgett. "Don't Go Near The Water." *Time.* August 1, 1988.

Brown, Lester R. *Building A Sustainable Society.* New York: W.W. Norton & Co., 1981.

Brown, Lester *et. al.* *State of the World: A Worldwatch Institute Report on Progress Toward a Sustainable Society.* New York: W.W. Norton & Co., 1987. "Realizing Recycling's Potential" by Cynthia Pollock.

Budiansky, Stephen. "Tons and Tons of Trash and No Place To Put It." *U.S. News and World Report.* December 14, 1987.

The Burning Question: Garbage Incineration vs. Total Recycling in New York City. NYPIRG, 9 Murray St., New York, NY 10007.

Cate, Richard, Nancy Everhart Collins, and Jonathan Lash. "Cleaning Up Solid Waste." *Vermont Affairs.* Winter 1988.

Characterization of Municipal Solid Waste in the United States, 1960-2000. Prairie Village, KS: Franklin Associates, Ltd., 1986. (Prepared for the US EPA.)

Commonwealth of Massachusetts. Executive Office of Environmental Affairs, Department of Environmental Protection. *The Commonwealth's Solid Waste Masterplan: Towards a System of Integrated Solid Waste Management.* Second Draft, October 1989. Final draft, April 1990. Available from the State House Bookstore, Rm. 116, State House, Boston, MA 02133.

Commonwealth of Massachusetts. Executive Office of Environmental Affairs, Department of Environmental Quality Engineering. *Plastics Recycling Action Plan for Massachusetts*, July 1988. Available from the State House Bookstore, Rm. 116, State House, Boston, MA 02133.

Concern, Inc. *Waste: Choices for Communities.* 1988. Concern, Inc., 1794 Columbia Rd., NW, Washington, DC 20009.

Crawford, John F., and Paul G. Smith. *Landfill Technology.* London: Butterworths, 1985.

Deagan, Kathleen. "Tracing the Waste Makers." *Archaeology.* January/February 1989, pp. 57-61.

Environmental Defense Fund. *Coming Full Circle: Successful Recycling Today.* Environmental Defense Fund, 1988. Guide to large-scale recycling nationwide for citizens, officials, and community organizers. Available for $12 from EDF, 257 Park Avenue South, New York, NY 10010.

50 Simple Things You Can Do To Save The Earth. Berkeley, CA: Earthworks Group, 1989.

Franklin, William E., Marjorie A. Franklin, and Robert G. Hunt. *Waste Paper: The Future of a Resource 1980-2000.* New York: American Paper Institute, 1982.

Fulford, Bruce. *Research Report On A Composting Greenhouse.* East Falmouth, MA: New Alchemy Institute, 1987.

"Garbage: A 413,000 Ton-A-Day Dilemma." *Inform Reports.* May/June 1985, Vol. 5, No. 3. Inform, Inc., 381 Park Avenue South, New York, NY 10016.

Hershkowitz, Allen. "Burning Trash: How It Could Work." *Technology Review.* Vol. 90, pp. 26-34, July 1987.

Klockenbrink, Myra. "Plastics Industry Under Pressure, Begins To Invest In Recycling." *The New York Times* August 30, 1988. p. C4.

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LeBlanc, Stephen J. *Up In Smoke: Will Massachusetts Gamble On Incineration and Forfeit a Recycling/Composting Future?* Boston: MASSPIRG, February, 1988.

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Morris, David and Neil Seldman. "New Ways to Keep a Lid on America's Garbage Problem," *Wall Street Journal.* April 15, 1986.

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FOR STUDENTS

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Amazing Life Games Company. *Good Cents: Every Kid's Guide To Making Money.* Boston: Houghton Mifflin Company, 1974. Lots of reuse and recycling ideas. 128 pp. (grades 4-6)

Beam, Rona. *What Happens To Garbage?* New York: Julian Messner, 1975. 62 pp. Manhattan sanitation workers, waste hauling, landfills, brief look at recycling and energy recovery.

Beck, Melinda, *et. al.* "Buried Alive," *Newsweek*, November 27, 1989, pp. 67-76.

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Bodecker, N.M. *The Mushroom Center Disaster*. New York: Atheneum, 1974, 48 pp. Mushroom-dwelling insect community solves litter problems through creative reuse.

Chargin, Claudia. *It's Your World*. San Francisco: Troubador Press, 1971.

Chester, Michael. *Let's Go to a Recycling Center*. Putnam, 1977, 47 pp. All aspects of the recycling process. Good primer for field trips. (grades 4-6)

Cobb, Vicki. *The Secret Life of Hardware: A Science Experiment Book*. New York: J.B. Lippincott, 1982. (grades 4-8)

Cobb, Vicki. *The Secret Life of School Supplies*. New York: J.B. Lippincott, 1981. Steps involved in the manufacture of paper, ink, pencils, chalk, glue and erasers. Experiments and formulas for making your own supplies. (grades 4-8)

Cox, Victoria and Stan Applebaum. *Nature's Assistant*. New York: Golden Press, 1974

Davis, Bertha and Susan Whitfield. *The Coal Question*. New York: Franklin Watts, 1982. (grades 6-12)

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Elliot, Sarah M. *Our Dirty Land*. New York: Julian Messner, 1976. 64 pp. Solid waste problems, management options emphasizing recycling and energy recovery; use of public land for private profit; how students affect change by learning more, writing letters, etc.; legislation emphasized as cause and solution to environmental problems. (grades 4-6)

Environmental Action Coalition. *It's Your Environment: Things to Think About...Things to Do*. New York: Charles Scribner's Sons, 1976.

Fiarotta, Phyllis. *Snips, Snails and Walnut Whales*. New York: Workman Publishing Company, 1975.

Fisher, Leonard E. *The Glass Makers*. New York: Franklin Watts, Inc., 1965. History and techniques of early American papermaking.

Foote, Timothy. *The Great Ringtail Garbage Caper*. New York: Houghton Mifflin, 1980. 66 pp. A story about young garbage entrepreneurs who disturb the local raccoon community's foraging habits. (grades 4-6)

Gabel, Margaret. *Sparrows Don't Drop Candy Wrappers*. New York: Dodd, Mead, 1971. 62 pp. Examines individual behavior regarding environmental pollution of all kinds. Builds awareness of interrelatedness with no scientific treatment of subject. (grades 4-6)

Gibbons, Gail. *Paper, Paper Everywhere*. New York: Harcourt, Brace Jovanovich, 1983. Good illustrations. How paper is made and what it is used for; little reference to recycling or conservation. (grades K-6)

Graham, Ada and Frank Graham, Jr. *The Big Stretch*. New York: Alfred A. Knopf, 1985. How rubber bands are made. (grades 4-8)

Graham, Ada and Frank Graham, Jr. *The Careless Animal: Nine Ecological Detective Stories*. Doubleday, 1975. 95 pp. Interrelationships between human and animal life as affected by technology and invention. Light on hazardous and solid waste. (grades 4-6)

Grummer, Arnold E. *Paper By Kids*. Minneapolis, MN: Dillon Press, Inc., 1980. History of paper and how to make it by hand.

Gutnik, Martin J. *Ecology and Pollution/Land*. Chicago: Children's Press, 1973.

Hahn, James and Lynn Hahn. *Recycling--Reusing Our World's Solid Wastes*. New York: Franklin Watt, Inc., 1973. Thorough and concise nonfiction. (grades 4-8)

Harris, Joanna C. *Let's Go to a Sanitation Department*. New York: G.P. Putnam & Sons, 1972. Sanitation departments and waste disposal.

Harwood, Pearl Augusta. *The Rummage Sale of Mr. and Mrs. Bumba*. Minneapolis, MN: Lerner Publications Company, 1971.

Hennings, George. *Keep Earth Clean, Blue, and Green*. 1976. Activities for home and school. Includes solid waste and recycling. (grades K-8)

Hilton, Suzanne. *How Do They Get Rid of It?* Philadelphia, PA: Westminster Press, 1970. (grades 4-8)

Hoff, Syd. *The Litter Knight*. McGraw-Hill, 1970, 35 pp. Knights, dragons, waste management.

Holliman, Jonathan. *Waste Age Man*. 1979. Human use of limited natural resources in industrial society. Includes problems, solutions, political and social effects. (grades 4-8)

Hughye, Pat. *Scavengers and Decomposers: The Cleanup Crew*. New York: Atheneum Publishers, 1984, 54 pp. Nature's recycling. (grades 4-6)

Hyde, Margaret Oldrogy. *For Pollution Fighters Only*. New York: McGraw-Hill, 1971, 157 pp. Scientific background for community action.

Inoue, B. *Handmade For Kids*. New York: St. Martin's, 1983.

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Kataoka, Barbara Slavin. *Pictures and Pollution*. Children's Press, 1977, 39 pp. Fine art representations of environment through history. (grades 4-6)

Klagsbrun, Francine. *Read About the Sanitation Man*. Watts, 1972. 69 pp. History of waste management, city waste disposal, waste management options.

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Lauber, Patricia. *Too Much Garbage*. Chicago, IL: Garrand Publishing Co., 1974. Nonfiction covering garbage from home, packaging, community waste management, landfills, incineration, and recycling.

Lawrence, Ester Hauser. *B-9, The Hungry Metal Eater*. New York: Rand McNally, 1970.

Leaf, Munro. *Who Cares? I Do*. J.B. Lippincott, 1971, 35 pp. Littering, individual responsibility and action.

Lefkowitz, R.J. *Save It! Keep it! Use It Again! A Book About Conservation and Recycling*. New York: Parents Magazine Press, 1977, 62 pp. Nonfiction. (grades 4-6)

Lipsett, Charles. *100 Years of Recycling*. 1974. All major developments in recycling, successful and failed projects in private and public sectors. (grades 9 to adult)

Lyth, Mike. *The War On Pollution*. Priory Press, 1977. 87 pp. Family and global polluting examples including packaging, pesticides, solid waste, and recycling.

Mackenzie, Joy, and Imogene Forte. *Kid's Stuff: Social Studies*. Nashville, TN: Incentive Publications, 1976.

Marshall, James. *Going to Waste*. New York: Coward, McCann and Geogheagan, Inc., 1972. Out of date on waste-to-energy plants; otherwise useful background on packaging, changing habits, and increasing recycling potential. (grades 4-6)

McCue, George. *Ecology: The City*. Benzinger, 1971, 64 pp. Includes disease and waste disposal, landfills, and incineration. (grades 4-6)

Miles, Betty. *Save the Earth! An Ecology Handbook for Kids*. New York: Alfred Knopf, 1974. (grades K-6)

Milgrom, Harry. *ABC of Ecology*. Macmillan, 1972, 30 pp. Alphabet of pollution concepts, science emphasis.

Moore, Lillian. *Junk Day on Juniper Street*. New York: Parents Magazine Press, 1969. (grades K-3)

Peet, Bill. *The Wump World*. Boston: Houghton Mifflin Company, 1970, 44 pp. Pollutians from planet Pollutus almost destroy the pleasant, clean world of the Wumps. (grades K-3)

Pflug, Betsy. *You Can*. New York: Van Nostrand Reinhold Co. Reuse ideas for cans. (grades K-3)

Poulet, Virginia. *Blue Bug's Beach Party*. Chicago: Children's Press, 1975, 31 pp. Litter clean-up.

Pounds, Elenor. *Wastebasket Full, Wastebasket Empty*. New York: Alfred A. Knopf, 1986.

Pringle, Lawrence. *Recycle Resources*. New York: Macmillan Publishing Co., 1974.

Throwing Things Away: From Middens to Resource Recovery. New York: Thomas Y. Crowell, 1986. Describes the phenomenon of garbage, what it can indicate about particular cultures, and past and present problems and methods of solid waste disposal and management. (grades 4-12)

Rippy Rachel, ed. *Finding and Using Scrounge Materials*. Washington, DC: Office of Education, 1975. Project ideas for reusing waste materials.

Rickwell, Harlow. *The Compost Heap*. Garden City, NY: Doubleday & Co., Inc., 1974. Simple, nicely illustrated. (grades K-6)

Seuss, Dr. *The Lorax*. Random House, 1971, 63 pp. Depleting natural resources and polluting the earth. (all ages)

Seymour, John. *Blueprint For A Green Planet: Your Practical Guide to Restoring the World's Environment*. New York: Prentice Hall, 1987. (grades 7-12)

Shanks, Ann Zane. *About Garbage and Stuff*. New York: The Viking Press, Inc., 1973, 36 pp. Trash, landfills, recycling glass, metal, paper. Reduce waste through conservation and reuse. Story about a family's recycling efforts and children's participation. (grades 1-3)

Showers, Paul. *Where Does the Garbage Go?* New York: Thomas Y. Crowell, Co., 1974, 33 pp. Good illustrations. Problems of dumping and burning, solutions, waste composition, urban vs. rural disposal, energy recovery process.

Shuttlesworth, Dorothy E. *Litter - The Ugly Enemy: An Ecology Story*. Garden City, NY: Doubleday, 1973, 61 pp. Recycling, litter prevention, community efforts. (grades 3-6)

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What Are Me and You Gonna Do? Children's Letters to Senator Gaylord Nelson about the Environment. Ballantine, 1971, 63 pp. In response to Earth Day 1970, covering all environmental aspects.

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Woods, Geraldine and Harold Woods. *Pollution.* New York: Franklin Watts, 1985.

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- Activities:
  - What Is Waste
  - Solid Waste Management in Massachusetts
  - Solid Waste Disposal Methods: Source Reduction
- Glossary

Division of Solid Waste Management:
- Background Information (including Plastics Fact Sheet)
- Activities:
  - Solid Waste Disposal Methods:
    - Recycling, Composting, Combustion, and Landfills
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